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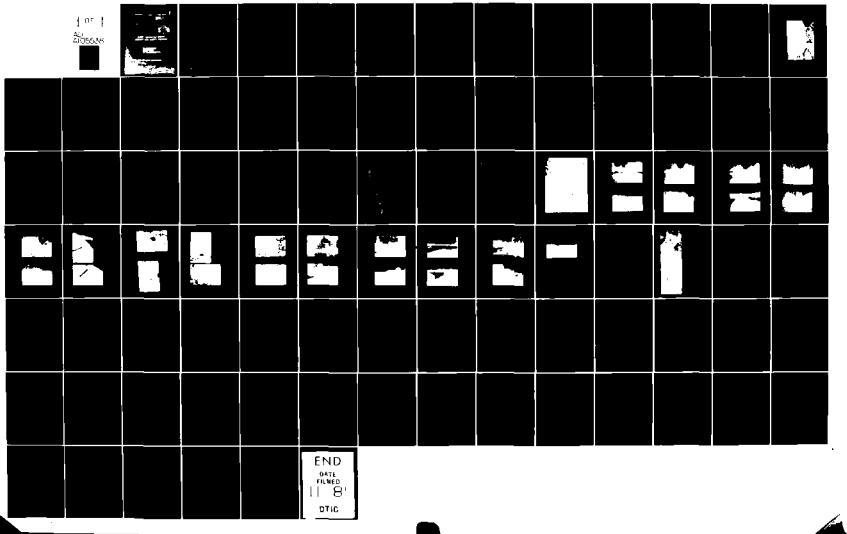

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

LITTLE BEAR LAKE DAM
CAPE GIRARDEAU COUNTY, MISSOURI
MISSOURI IDENTIFICATION NO. MO 30533

PHASE I INSPECTION REPORT

(6) NATIONAL DAM SAFETY PROGRAM.

Little Bear Lake Dam (MO 30533),
Mississippi - Kaskaskia - St. Louis Basin,
Cape Girardeau County, Missouri. Phase I
Inspection Report.

PREPARED BY
HOSKINS-WESTERN-SONDEREGGER, INC.
CONSULTING ENGINEERS
LINCOLN, NEBRASKA

UNDER DIRECTION OF

ST. LOUIS DISTRICT, CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO ATTENTION OF

SUBJECT: Little Bear Lake Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Little Bear Lake Dam (M030533).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria.

a. Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.

b. Overtopping of the dam could result in failure of the dam.

c. Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED
Chief, Engineering Division

28 MAY 1981
Date

APPROVED BY: SIGNED
Colonel, CE, District Engineer

29 MAY 1981
Date

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM
ASSESSMENT SUMMARY

Name of Dam	Little Bear Lake Dam
State Located	Missouri
County Located	Cape Girardeau County
Stream	Tributary to Cape La Croix Creek
Date of Inspection	October 28, 1980

Little Bear Lake Dam was inspected by an interdisciplinary team of engineers from Hoskins-Western-Sonderegger, Inc. The purpose of the inspection was to make an assessment of the general conditions of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers.

Little Bear Lake Dam has a height of thirty-two (32) feet and a storage capacity at the minimum top elevation of the dam of sixty-one (61) acre-feet. In accordance with the guidelines, a small size dam has a height greater than or equal to twenty-five (25) feet but less than forty (40) feet and a storage capacity greater than or equal to fifty (50) acre-feet but less than one thousand (1,000) acre-feet. The size classification is determined by either the storage capacity or height, whichever gives the larger size category. Little Bear Lake Dam is classified as a small size dam.

In accordance with the guidelines and based on visual observation, the dam is classified as having a high hazard potential. Failure would threaten life and property. The estimated damage zone extends approximately two (2) miles downstream of the dam. Within the damage zone are fifteen dwellings within the first 0.3 miles; three barns at 0.5 miles; thirty or more dwellings from 0.55 to 0.9 miles; eight dwellings, a large building, and a road from 0.9 to 1.1 miles; three buildings at 1.3 miles; and six dwellings and a road from 1.4 to 1.55 miles.

The inspection and evaluation indicates that the spillways do not meet the criteria set forth in the "Recommended Guidelines for Safety Inspection of Dams" for a small dam having a high hazard potential. Considering the small volume of water impounded, 50% of the Probable Maximum Flood is the appropriate design flood. The spillways will pass the 100-year flood (1% probability flood - a flood having a 1% chance of being exceeded in any one year) without overtopping the dam. The spillways will also pass 30% of the Probable Maximum Flood without overtopping the dam. The Probable Maximum Flood is defined as the flood that may be expected from the most severe

combination of critical meteorologic and hydrologic conditions that are possible in the region.

Little Bear Lake Dam does not show any apparent signs of structural distress and appears to be in good condition. The deficiencies noted are inadequate spillway capacity; the lack of seepage and stability analyses as required by the guidelines for all dams having a high hazard potential; growth of trees and brush on the embankment; erosion and headcutting along the downstream toe; accumulation of debris, logs and trash in the principal spillway inlet; lack of an adequate trash rack on the principal spillway inlet and a small amount of water flowing from the principal spillway conduit when the lake level was below the weir level of the inlet. A lack of routine maintenance was apparent.

The construction of a sewage lagoon immediately downstream from the dam has altered the direction of flow of surface runoff from the residential area lying to the west of the lake as well as potential emergency spillway discharges. The original intent was that these discharges would follow a natural drainageway which would carry flow away from the toe of the dam. The sewage lagoon now occupies the natural drainageway, and flows are now directed between the lagoon and the dam causing erosion and headcutting along the toe of the dam. A further study should be made by the owner, on a high priority basis, to determine whether an erosion resistant channel capable of safely carrying emergency spillway flows equivalent to 50% of the probable maximum flood plus the concurrent surface runoff from 10 acres of residential area can be constructed through the narrow constriction between the northeast corner of the sewage lagoon and the toe of the dam. The study should determine the feasibility of the alternatives recommended in paragraphs a.(1) and a.(2) below as well as any others that would meet the basic goal of safely passing 50% of the probable maximum flood through erosion resistant spillways without overtopping the dam. All alternatives studied should include the safe passage of surface runoff water from 10 acres of residential development in an erosion resistant channel between the sewage lagoon and the toe of the dam. This study should be made by a professional engineer experienced in the design and construction of dams. Based on the results of this study, the alternatives listed below are recommended:

a. Alternatives.

(1) If the study recommended above shows that it is feasible to route emergency spillway flows safely along the downstream toe of the dam, the following alternative is recommended: Increase the spillway size and/or height of the dam in order to pass 50% of the probable maximum flood without overtopping the dam. Construct an erosion resistant channel between the sewage lagoon and the toe of the dam that will safely handle 50% of the probable maximum flood in addition to the concurrent surface runoff from 10 acres of residential development.

(2) If the study recommended above shows that it is not feasible to route emergency spillway flows safely along the downstream toe of the dam, the following alternative is recommended: Close the existing emergency spillway; raise the crest elevation of the dam to a uniform elevation equal to the high point on the crest (512.5) and construct a new emergency spillway with erosion control through the left (east) abutment of the dam that will pass 50% of the probable maximum flood without overtopping the dam. In addition an erosion resistant channel should be constructed between the sewage lagoon and the toe of the dam that will safely deliver the surface runoff from 10 acres of residential development to the channel downstream from the dam.

(3) If the recommended study shows that another alternative is more feasible than the alternatives listed above and meets the requirement of safely passing 50% of the probable maximum flood through erosion resistant spillways without overtopping the dam, that alternative should be implemented.

(4) Due to the large number of dwellings located in the downstream damage zone, it is recommended that a reliable flood warning system and evacuation plan be provided.

b. Operation and Maintenance Procedures. The following operation and maintenance procedures are recommended:

(1) Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" should be performed. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) by a professional engineer experienced in the design and construction of dams.

(2) The trees growing on the upstream slope as well as all of the trees and brush growing on the downstream slope should be removed. Tree removal should be done under the guidance of a professional engineer experienced in the design and construction of dams. Measures should be taken to prevent tree and brush growth in the future. A vegetative growth of adapted grasses and legumes should be established after removal of the trees and brush.

(3) Repair of the erosion and headcutting along the toe of the dam should be done under either of the alternatives recommended in paragraph 7.2.a.

(4) The source of the water flowing from the principal spillway conduit during periods when the spillway is not discharging due to the lake level should be determined. Remedial measures might be indicated.

(5) The debris, logs and trash should be removed from the principal spillway inlet.

(6) An adequate trash rack should be installed at the principal spillway inlet.

(7) Trees and brush should be removed from the downstream channel to a point south of the sewage lagoon.

(8) A program of regular maintenance and periodic inspections should be initiated. Records of inspections should be made a part of this project file.

Rey S. Decker
E-3703

Gordon Jamison

Harold Ulmer
Garold Ulmer
E-19246

H. P. Hoskins
Harold P. Hoskins, Chairman of the Board
Hoskins-Western-Sonderegger, Inc.
E-8696

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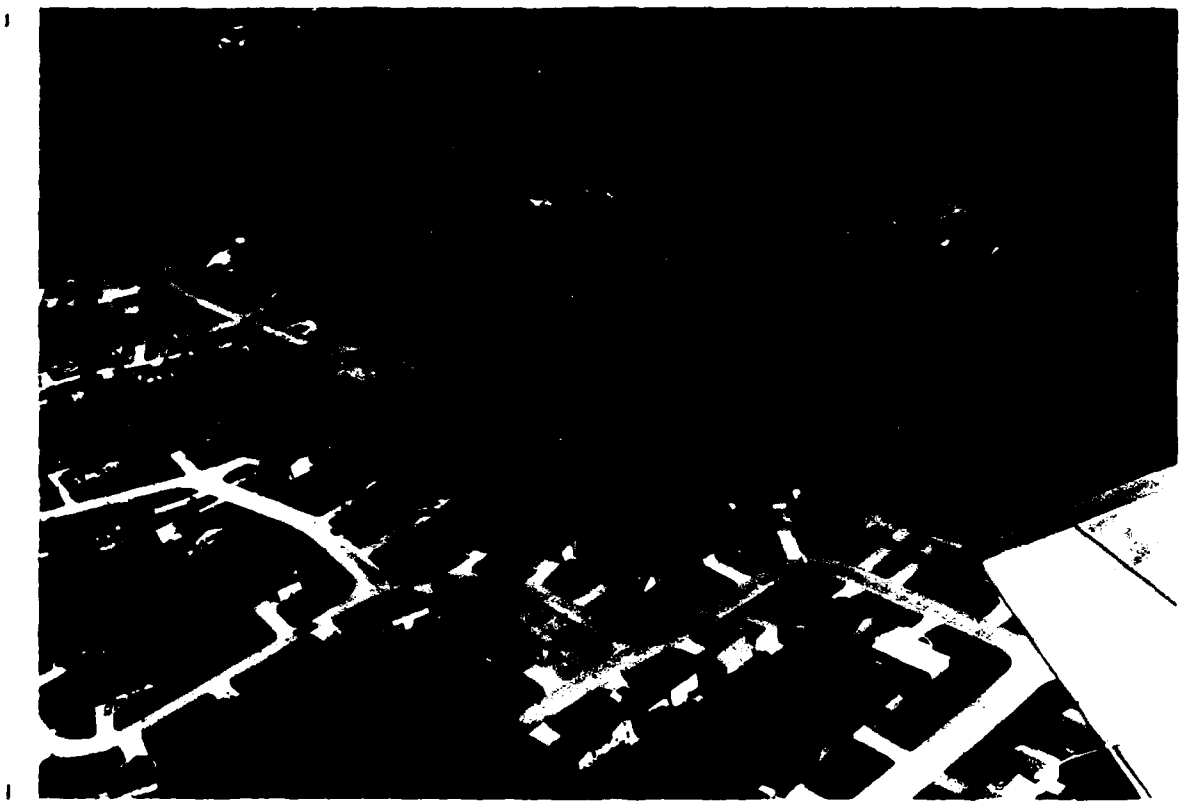


PHOTO NO. 1 - OVERVIEW

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LITTLE BEAR LAKE DAM - MO 30533
CAPE GIRARDEAU COUNTY, MISSOURI

SECTION I - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of Little Bear Lake Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams", Appendix D to "Report of the Chief of Engineers on the National Program of Inspection of Dams", dated May, 1975, and published by the Department of the Army, Office of the Chief of Engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances

(1) Embankment. The embankment is an earthfill dam constructed in a "dogleg" configuration. The dam is approximately 590 feet in length and 32 feet in height. The maximum water storage at the minimum top elevation of the dam is 61 acre-feet.

(2) Principal Spillway. The principal spillway is uncontrolled. It consists of a reinforced concrete riser with wire mesh trash rack and an 18-inch diameter corrugated metal pipe conduit passing through the base of the dam on a skew from Station 1+50 (upstream) to Station 2+00 (downstream).

(a) Inlet Structure. The inlet structure consists of a reinforced concrete riser. The structure is 2.2 feet long by 2.2 feet wide. The outlet pipe is located 12.7 feet below the weir which is a total of 6.6 feet long. The weir inlet to the riser is covered by a wire mesh trash rack. Photos 12 and 13 show the inlet of the principal spillway.

(b) Conduit. The conduit consists of 90 feet of 18-inch diameter corrugated metal pipe. The conduit has an inlet elevation of 495.3 feet M.S.L. and an outlet elevation of 484.6 feet M.S.L. Photos 14, 15 and 16 show the outlet of the conduit.

(c) Stilling Basin. There is no structural stilling basin for the principal spillway. Spillway discharges drop approximately 7.5 feet to the bottom of a natural channel approximately 6 feet wide. Photos 14, 16 and 17 show the spillway outlet channel.

(3) Emergency Spillway. The emergency spillway is an uncontrolled, vegetated earth cut through the right abutment. The spillway has a 35 to 40-foot bottom width with side slopes of 1V on 7H or flatter. The entrance channel is about 20 feet in length. There is a level control section 30 feet ± in length. Immediately downstream of the level section is a 36-foot wide concrete surfaced tennis court. The spillway discharges into a small natural drainageway which runs along the downstream toe of the dam and eventually into the principal spillway outlet channel immediately downstream from the principal spillway outlet. Photos 21, 22 and 23 show views of the emergency spillway.

(4) Low-Level Outlet. There is no low-level outlet or drawdown structure for this dam.

(5) Pertinent physical data are given in paragraph 1.3

b. Location. The dam is located in the east central portion of Cape Girardeau County, Missouri, as shown on Plate A-2. The dam is shown on Plate A-1 in Survey #2198 in the extreme north portion of the corporate limits of Cape Girardeau, Missouri.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Little Bear Lake Dam has a height of 32 feet and a storage capacity of 61 acre-feet. This dam is classified as a small size dam. A small size dam has a height greater than or equal to 25 feet but less than 40 feet and a storage capacity greater than or equal to 50 acre-feet but less than 1,000 acre-feet. The size classification is determined by either the storage or height, whichever gives the larger size category.

d. Hazard Classification. Guidelines for determining hazard classification of dams and impoundments are presented in the guidelines as referenced in paragraph 1.1c above.

Aerial photographs of the downstream damage zone of this dam were taken in October, 1980. These photographs were used as reference

in the field observations of the damage zone which were made during the inspection. Based on the field observations and on the referenced guidelines, this dam is in the High Hazard Potential Classification. The estimated damage zone extends approximately two miles downstream of the dam. Within the damage zone are fifteen dwellings within the first 0.3 miles; three barns at 0.5 miles; thirty or more dwellings from 0.55 to 0.9 miles; eight dwellings, a large building, and a road from 0.9 to 1.1 miles; three buildings at 1.3 miles; and six dwellings and a road from 1.4 to 1.55 miles.

e. Ownership. The dam is owned by the Lake View Home Owners' Assoc., Attention: John Freeze, P.O. Box 344, Cape Girardeau, Missouri 63701.

f. Purpose of Dam. The dam impounds a recreational lake covering about 6 acres and containing approximately 40 acre-feet of water at normal pool elevation.

g. Design and Construction History. The dam was constructed in 1963 by Mr. Russell Sohn. No other information was available on design or construction of the dam.

h. Normal Operating Procedure. There are no operating facilities for this dam. The pool level is controlled by rainfall, infiltration, evaporation, and the capacity of the uncontrolled spillways.

1.3 PERTINENT DATA

a. Drainage Area. 73 acres (0.114 square miles).

b. Discharge at Damsite.

(1) All discharges at the damsite are through the following:

(a) An uncontrolled reinforced concrete drop inlet which is connected to an 18-inch diameter corrugated metal pipe passing through the embankment.

(b) An uncontrolled vegetated earth emergency spillway.

(2) Estimated maximum flood at damsite -- unknown.

(3) The principal spillway capacity varies from 0 c.f.s. at elevation 508.0 feet to 25 c.f.s. at the crest of the emergency spillway (elevation 509.5 feet) to 26 c.f.s. at the minimum top of dam (elevation 511.3 feet).

(4) The emergency spillway capacity varies from 0 c.f.s. at its crest (elevation 509.5 feet) to 207 c.f.s. at the minimum top of dam (elevation 511.3 feet).

(5) Total spillway capacity at the minimum top of dam is 233 c.f.s. ±.

c. Elevations (feet above M.S.L.).

(1) Observed pool - 505.8

(2) Normal pool - 508.0

(3) Spillway crests

Principal - 508.0

Emergency - 509.5

(4) Maximum experienced pool - unknown

(5) Top of dam (minimum) - 511.3

(6) Streambed - 479±

(7) Maximum tailwater - unknown

d. Reservoir. Length (feet) of pool.

(1) At principal spillway crest - 850±

(2) At emergency spillway crest - 1000±

(3) At top of dam (minimum) - 1200±

e. Storage (acre-feet).

(1) Observed pool - 32±

(2) Normal pool - 40±

(3) Spillway crests

Principal - 40±

Emergency - 49±

(4) Maximum experienced pool - unknown

(5) Top of dam (minimum) - 61±

f. Reservoir Surface (acres).

(1) Observed pool - 5.3±

(2) Normal pool - 6.0±

(3) Spillway crests

Principal - 6.0±

Emergency - 6.4±

(4) Maximum experienced pool - unknown

(5) Top of dam (minimum) - 7.0±

g. Dam.

(1) Type - earthfill

(2) Length - 590 feet ±

(3) Height - 32 feet ±

(4) Top width - 10 feet ±

(5) Side slopes

(a) Downstream - 2.0H on 1V (measured)

(b) Upstream - 1.9H on 1V (measured on exposed face)

(6) Zoning - unknown

(7) Impervious core - unknown

(8) Cutoff - unknown

(9) Grout curtain - unknown

(10) Wave protection - vegetated upstream slope

(11) Drains - unknown

h. Diversion Channel and Regulating Tunnel. None

i. Spillways.

(1) Principal (uncontrolled)

(a) Type - reinforced concrete drop inlet (riser) with inside dimensions 2.2 feet wide by 2.2 feet long. The riser is approximately 12.7 feet deep. The conduit passing through the embankment is an 18-inch diameter corrugated metal pipe.

(b) Crest (invert) elevation - 508.0 feet (M.S.L.)

(c) Inlet (invert) elevation of conduit - 495.3 feet (M.S.L.)

(d) Outlet (invert) elevation of conduit - 484.6 feet (M.S.L.)

(e) Length of conduit - 90 feet ±

(2) Emergency

(a) Type - vegetated earth, uncontrolled, cut through the right abutment.

(b) Control section - vegetated earth, level section 30 feet in length, bottom width - approximately 35 feet, side slopes - approximately 1V on 7H.

(c) Crest elevation - 509.5

(d) Upstream channel - clear, stable, vegetated.

(e) Downstream channel - natural channel running along the toe of the downstream slope. Channel is completely covered with trees and brush.

j. Regulating Outlets. None

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No design data were available for this dam.

2.2 CONSTRUCTION

No construction data were available. It was reported by Mrs. John Freeze, former owner, that the dam was constructed in 1963 by Mr. Russell Sohn.

2.3 OPERATION

No data were available on spillway operation. It was reported by Mrs. Freeze that flows have never occurred in the emergency spillway.

2.4 EVALUATION

a. Availability. No data were available.

b. Adequacy. The field surveys and visual observations presented herein are considered adequate to support the conclusions of this report. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity. Not applicable.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of the Little Bear Lake Dam was made on October 28, 1980. Engineers from Hoskins-Western-Sonderegger, Inc., Lincoln, Nebraska, making the inspection were:

Rey S. Decker - Geotechnical
Garold G. Ulmer - Hydraulics and Hydrology
Gordon Jamison - Hydraulics and Hydrology
Roy Elliott - Geology

The owner was not represented during the inspection. The former owner, Mrs. John Freeze, was interviewed prior to the inspection.

b. Dam.

(1) Geology and Soils (abutment and embankment). The embankment is situated in the loess mantled uplands on the eastern border of the Ozark Physiographic Province. The predominate soil association is the Memphis-Loring silty clay loams. The predominate structural features are the Jackson fault, the Girardeau fault and the Brooks Dome. The embankment is located in Seismic Zone 3.

The embankment is composed of slightly plastic to moderately plastic clayey silts with a gravel fraction. These materials are derived from the 10 to 20-foot loess mantle and the underlying 5 to 15-foot residual alluvium and soil. The alluvium is composed of clayey silt with carbonate and chert sands and gravels. The underlying bedrock formation is the Devonian, Plattin formation, an evenly bedded limestone with chert nodules.

Seepage from the impoundment is controlled by the embankment, suggesting that the hydraulic conductivity of these materials equals or exceeds that of the alluvium.

A major probability of seismic activity exists at the site. Earthquakes with Modified Mercalli intensities of V or greater were recorded in 1812, 1819, 1878, 1882, 1903, 1905, 1909, 1930, 1974 and 1977.

Solution cavitation was not detected in the vicinity and is not likely to occur in the underlying limestones.

Sinkhole collapse induced by leaky impoundments is not reported in this region by Aley, Williams & Massello, 1972 (Engineering Geology Service No. 5, Missouri Geologic Survey and Water Resources).

(2) Upstream Slope. The upstream slope of the dam is well vegetated with grass and weed growth which has provided good erosion control. No significant erosion was observed. Sizable willow trees, 6 to 9 inches in diameter, are growing at Stations 1+00±, 4+00± and 5+40±. No slumps, slides, cracks, deformations or rodent holes were observed. The upstream slope is shown in Photos 2, 3 and 12.

(3) Crest. The crest of the dam is well vegetated with grass and weed growth. No cracks, deformations, rodent holes, or signs of excessive settlement were observed on the crest. The profile of the crest is fairly uniform with a maximum variation in elevation of 1.2± feet. Plate C-1 shows the centerline profile of the dam. The crest is free of tree and brush growth. Materials in the crest are ML-CL (high in silt content). The crest is shown in Photos 4, 5 and 6.

(4) Downstream Slope. The downstream slope is almost completely overgrown with trees and brush as shown in Photos 1, 8, 9, 10 and 11. The trees vary in size from 1 to 1½ inches in diameter to 8 to 10 inches in diameter. The inspection revealed no cracks, slumps, slides, erosion, deformations or rodent holes on the slope. However, a channel is being eroded along the toe of the dam beginning at the downstream channel and extending approximately 100 feet to the northwest terminating in a headcut (Photo No. 18) which is approximately 2 to 3 feet deep. Periodic flows of sizable quantities of water are causing this erosion. The source of the water is surface runoff from approximately 10 acres of residential development lying to the west of the dam. Prior to the construction of the small sewage lagoon downstream from the dam, the surface runoff followed a natural channel that merged with the downstream channel of the dam approximately 400 feet south of the dam. The lagoon was constructed in the channel that formerly carried the surface runoff water. A dike along the north side of the lagoon prevents water from entering the lagoon, and the flow now is carried between the toe of the dam and the lagoon dike entering the downstream channel of the dam near the toe of the dam. Any flow through the emergency spillway will follow this same route. Plate A-1 shows the topography of the area prior to construction of the lagoon. Photo No. 1 shows the location of the lagoon in relation to the dam.

Seepage estimated as 0.1 gpm or less was observed in the eroded channel along the toe of the dam. Seepage was also observed entering the downstream channel approximately 10 feet from the end of the principal spillway. The volume of flow from this seep is very small and does not appear to be significant. A growth of cattails downstream from Station 5+00 (Photo No. 14) may indicate seepage or poor surface drainage conditions in this area. Surface water was not observed. No evidence of overtopping was observed.

c. Appurtenant Structures.

(1) Principal Spillway.

(a) Inlet Structure. The principal spillway inlet, a reinforced concrete drop structure 2.2 feet square and 12.7 feet deep, appears to be in good structural condition. The efficiency of the spillway is detrimentally affected by an accumulation of debris, logs and trash at the bottom of the inlet. The wire mesh covering the inlet (Photos 12 and 13) can easily clog with weeds, debris and logs with further reduction of spillway efficiency. A cold joint in the concrete indicates the possibility that the crest has been raised approximately 12 inches sometime in the past.

(b) Conduit. The outlet end of the 18-inch diameter conduit was the only portion of the conduit that could be observed, and it was in good condition. There was no seepage observed on the exterior of the conduit. A small amount of water was flowing from the end of the conduit. The lake level was well below the spillway crest elevation which would indicate a leak in the spillway conduit or possibly in the spillway riser. Photos 14, 15 and 16 show the outlet end of the spillway conduit.

(c) Stilling Basin. There is no stilling basin for the principal spillway. Flows from the conduit drop approximately 7.5 feet to the bottom of the downstream channel. Flows through the principal spillway have not eroded the downstream channel to any noticeable degree.

Some minor undercutting has occurred under the end of the spillway conduit. Photos 14, 15 and 16 show the conditions at the outlet end of the spillway conduit.

(2) Emergency Spillway. The emergency spillway is in good condition. The vegetative cover consists of grass and weed growth. There were no obstructions in the spillway. Photos 21 and 22 show views of the emergency spillway.

(3) Low-Level Outlet. There is no low-level outlet.

d. Reservoir Area. The shoreline of the reservoir is well vegetated with no significant erosion. There was no evidence of heavy siltation. Photos 1, 7, 23, 24 and 25 show views of reservoir.

e. Downstream Channel. The downstream channel from the dam is overgrown with trees and brush. The heavy brush and tree growth could possibly cause backwater effect from spillway flow on the downstream toe of the dam. More detailed information is needed to determine the extent and/or effect it could have on the toe. The channel appears to be stable with no noticeable signs of erosion.

3.2 EVALUATION

This dam appears to be in good condition except for the heavy tree and brush growth and the channel that is being eroded along the toe of the dam. There is little potential of failure at the present time; however, the continued growth of trees and brush on the embankment and unchecked erosion along the toe of the dam could lead to failure of the dam. The debris, logs and trash should be removed from the principal spillway inlets and an adequate trash rack should be installed.

Seepage observed downstream from the dam in the outlet channel and in the eroded channel downstream from about Station 2+75 does not appear to affect the integrity of the dam.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

There are no controlled outlet works for this dam. The pool level is controlled by rainfall, infiltration, evaporation, and the capacity of the uncontrolled spillways.

4.2 MAINTENANCE OF DAM

The extensive tree growth on the downstream slope of the dam, tree growth on the upstream slope, erosion along the toe of the dam and the debris in the bottom of the spillway riser would indicate a lack of maintenance.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities exist at this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no warning system in effect for this dam.

4.5 EVALUATION

The deficiencies observed during the inspection are due to a lack of routine maintenance.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. No design data were found for this dam.

b. Experience Data. The drainage area, reservoir surface area, and elevation-storage data were developed from the USGS Cape Girardeau, Missouri 7-1/2 minute topographic quadrangle map. The hydraulic computations for the spillway and dam overtopping discharge ratings were based on data collected in the field at the time of the field inspection. Hydraulic/hydrologic computations are included as Appendix D of this report.

c. Visual Observations.

(1) The spillway drop inlet and outlet pipe appeared to be in good condition. However, there was some debris, logs and trash noted in the bottom of the spillway riser. There was a small discharge coming out of the outlet pipe even though the reservoir level was below the crest of the riser indicating an apparent leak in the pipe or riser.

(2) The spillway riser had a wire mesh trash rack over it (see Photos 12 and 13). The trash rack is inadequate and could result in possible clogging of the spillway inlet if not kept clear of debris and vegetation.

(3) The spillway riser appeared to have had an extra one foot added in height to the riser at sometime in the past.

(4) The principal spillway outlet channel is heavily overgrown with trees and brush.

(5) The emergency spillway appeared to be in good condition. A tennis court is located in the spillway channel. The exit channel runs along the toe of the downstream slope and is heavily overgrown with trees and brush. Spillway discharges will flow along the toe of the dam.

(6) There is no drawdown facility for this structure.

d. Overtopping Potential. The spillways are too small to pass the probable maximum flood or 50% of the probable maximum flood without overtopping. The spillways will pass the one percent probability flood as well as 30% of the probable maximum flood without overtopping the dam. Overtopping is dangerous because the flow of water over the crest could erode the face of the dam and, if continued long enough, could breach the dam with sudden release of all of the impounded water into the downstream floodplain.

The results of the routings through the dam are tabulated in regards to the following conditions:

Frequency	Inflow Discharge c.f.s.	Outflow Discharge c.f.s.	Maximum Pool Elevation	*Maximum Depth Over Dam Feet	Duration Over Top Hours
1% Flood	200	24	509.3	0	0
1/2 PMF	700	570	512.0	0.7	1-
PMF	1400	1390	512.5	1.2	3+
0.30 PMF	240	420	511.3	0	0

*Minimum top of dam elevation - 511.3

According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, this dam is classified as having a high hazard rating and a small size. Therefore, the 1/2 PMF to PMF is the test for the adequacy of the dam and its spillway.

The estimated damage zone is described in paragraph 1.2d in this report.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observation. Based on visual observation this dam appears to be structurally stable against shear failures and normal seepage pressures. Signs of distress such as cracks, slides, slumps, deformations or rodent burrows were not observed. Erosion other than that along the toe of the dam caused by surface runoff from the residential area west of the lake was not observed.

b. Design and Construction Data. Design and construction data were not available. The dam was constructed by Mr. Russell Sohn. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Operating Records. There are no controlled operating facilities for this dam.

d. Post-Construction Changes. The inspection team is not aware of any post-construction changes in the dam. The sewage lagoon downstream of the dam was constructed after the dam was constructed. It occupies the downstream channel through which emergency spillway discharges were meant to flow. As a result, any emergency spillway discharge will flow between the lagoon and the toe of the dam.

e. Seismic Stability. This dam is located in Seismic Zone 3 as shown on Plate A-3. An earthquake of the magnitude predicted in this area could be hazardous to this dam. Stability analyses for this dam should include earthquake forces applicable to Seismic Zone 3.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Based on visual observations this dam does not appear to have a serious potential of failure at this time. The dam appears to be structurally stable with no evidence of cracks, slides, slumps, deformations, or rodent activity. The growth of trees and brush on the dam, as well as the channel erosion and headcutting at the toe of the dam, could lead to failure in the future if not corrected. The sewage lagoon that has been constructed in the natural channel that formerly carried surface runoff and emergency spillway flows has caused these flows to be routed along the toe of the dam. This is not good practice and will require construction of an erosion resistant channel and protection of the toe of the dam in order to prevent damage and possible failure. The approximate analyses performed for this report indicate that the spillways will pass the 1% probability flood as well as 30% of the probable maximum flood without overtopping the dam. The probable maximum flood will overtop the dam about 1.2 feet for approximately three hours. In accordance with the "Recommended Guidelines for Safety Inspection of Dams" the capacity of the spillways is inadequate for a small dam having a high hazard potential rating. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

b. Adequacy of Information. Due to the lack of engineering data, the conclusions in this report are based upon performance history and visual observations. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency. A program should be developed as soon as possible to monitor at regular intervals the deficiencies described in this report. The remedial measures recommended in paragraph 7.2b should be accomplished in the near future. The items recommended in paragraph 7.2a should be pursued on a high priority basis.

d. Necessity for Further Investigations. A study should be made to determine whether an erosion resistant channel capable of safely carrying emergency spillway flows equivalent to 50% of the probable maximum flood plus the concurrent surface runoff from 10 acres of residential area can be constructed through the narrow constriction between the northeast corner of the sewage lagoon and the toe of the dam. The study should determine the feasibility of the alternatives recommended in paragraphs 7.2a.(1) and 7.2a.(2) as well as any others that would meet the basic goal of safely passing 50% of the probable maximum flood through erosion resistant spillways without overtopping the dam. All alternatives studied should include

the safe passage of surface runoff water from 10 acres of residential development in an erosion resistant channel between the sewage lagoon and the toe of the dam.

This study should be made by a professional engineer experienced in the design and construction of dams. Based on the results of this study the alternatives listed in paragraph 7.2a are recommended. This study should be accomplished by the owner on a high priority basis.

e. Seismic Stability. This dam is located in Seismic Zone 3 as shown on Plate A-3. An earthquake of this magnitude could be hazardous to this dam. It is recommended that the prescribed seismic loading for Seismic Zone 3 be applied in any stability analyses performed for this dam.

7.2 REMEDIAL MEASURES

The following remedial measures and maintenance procedures are recommended. All remedial measures should be performed under the guidance of a registered professional engineer experienced in the design and construction of earth dams.

a. Alternatives.

(1) If the study recommended in paragraph 7.1d shows that it is feasible to route emergency spillway flows safely along the downstream toe of the dam, the following alternative is recommended: Increase the spillway size and/or height of the dam in order to pass 50% of the probable maximum flood without overtopping the dam. Construct an erosion resistant channel between the sewage lagoon and the toe of the dam that will safely handle 50% of the probable maximum flood in addition to the concurrent surface runoff from 10 acres of residential development.

(2) If the study recommended in paragraph 7.1d shows that it is not feasible to route emergency spillway flows safely along the downstream toe of the dam, the following alternative is recommended: Close the existing emergency spillway; raise the crest elevation of the dam to a uniform elevation equal to the highpoint on the crest (512.5) and construct a new emergency spillway with erosion control through the left (east) abutment of the dam that will pass 50% of the probable maximum flood without overtopping the dam. In addition an erosion resistant channel should be constructed between the sewage lagoon and the toe of the dam that will safely deliver the surface runoff from 10 acres of residential development to the channel downstream of the dam.

(3) If the recommended study shows that another alternative is more feasible than the alternatives listed above and meets the requirement of safely passing 50% of the probable maximum flood through erosion resistant spillways without overtopping the dam, that alternative should be implemented.

(4) Due to the large number of dwellings located in the downstream damage zone, it is recommended that a reliable flood warning system and evacuation plan be provided.

b. Operation and Maintenance Procedures.

(1) Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" should be performed. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) by a professional engineer experienced in the design and construction of dams.

(2) The trees growing on the upstream slope as well as all of the trees and brush growing on the downstream slope should be removed. Tree removal should be done under the guidance of a professional engineer experienced in the design and construction of dams. Indiscriminate clearing could jeopardize the safety of the dam. Measures should be taken to prevent tree and brush growth in the future. A vegetative growth of adapted grasses and legumes should be established after removal of the trees and brush.

(3) Repair of the erosion and headcutting along the toe of the dam should be done under either of the alternatives recommended in paragraph 7.2a.

(4) The source of the water flowing from the principal spillway conduit during periods when the spillway is not discharging due to the lake level should be determined. Remedial measures might be indicated.

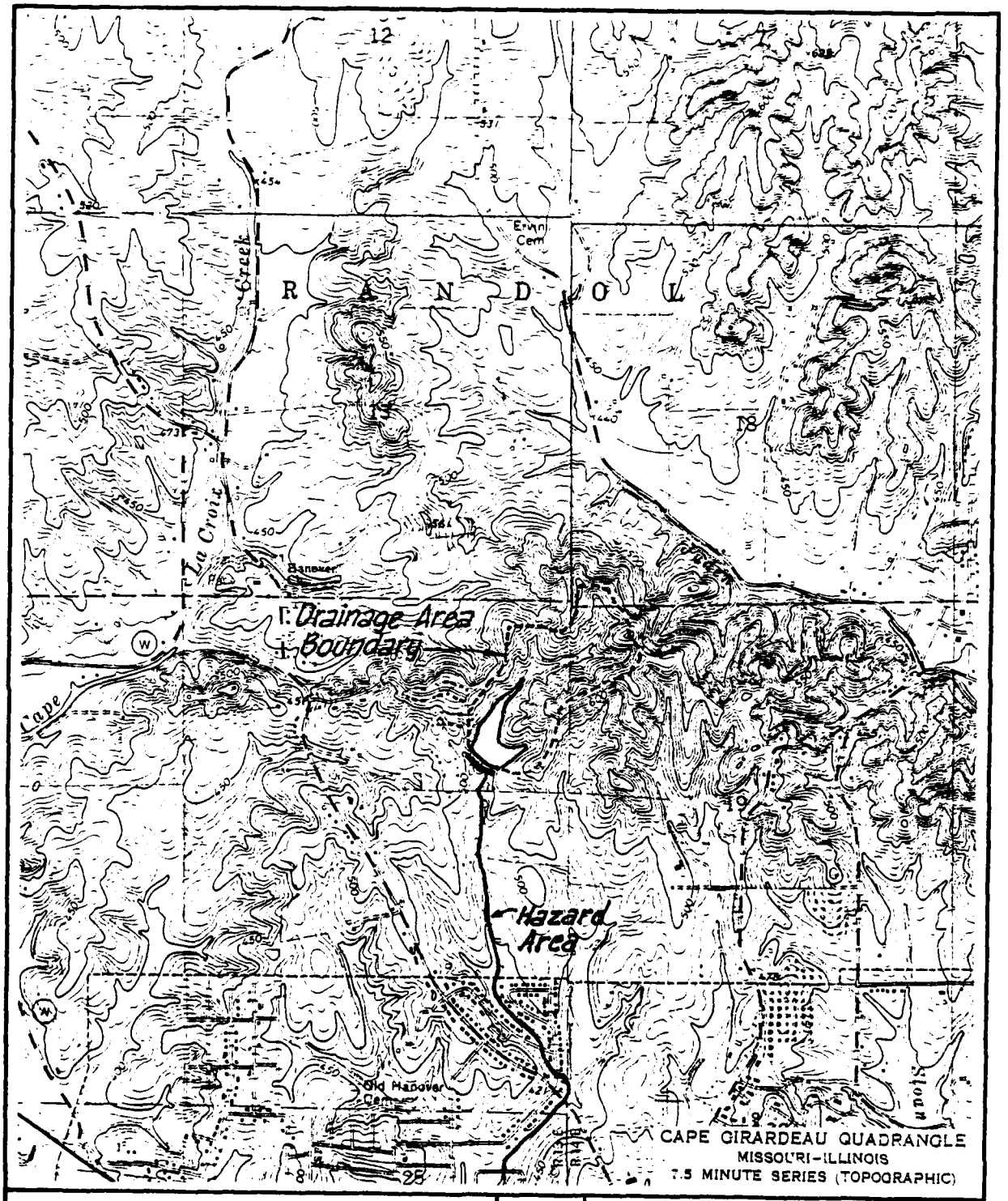
(5) The debris, logs and trash should be removed from the principal spillway inlet.

(6) An adequate trash rack should be installed at the principal spillway inlet.

(7) Trees and brush should be removed from the downstream channel to a point south of the sewage lagoon.

(8) A program of regular maintenance and periodic inspections should be initiated. Records of inspections should be made a part of this project file.

APPENDIX A
MAPS



Scale in feet

2000 1000 0 2000 4000

Contour Interval – 10'

N

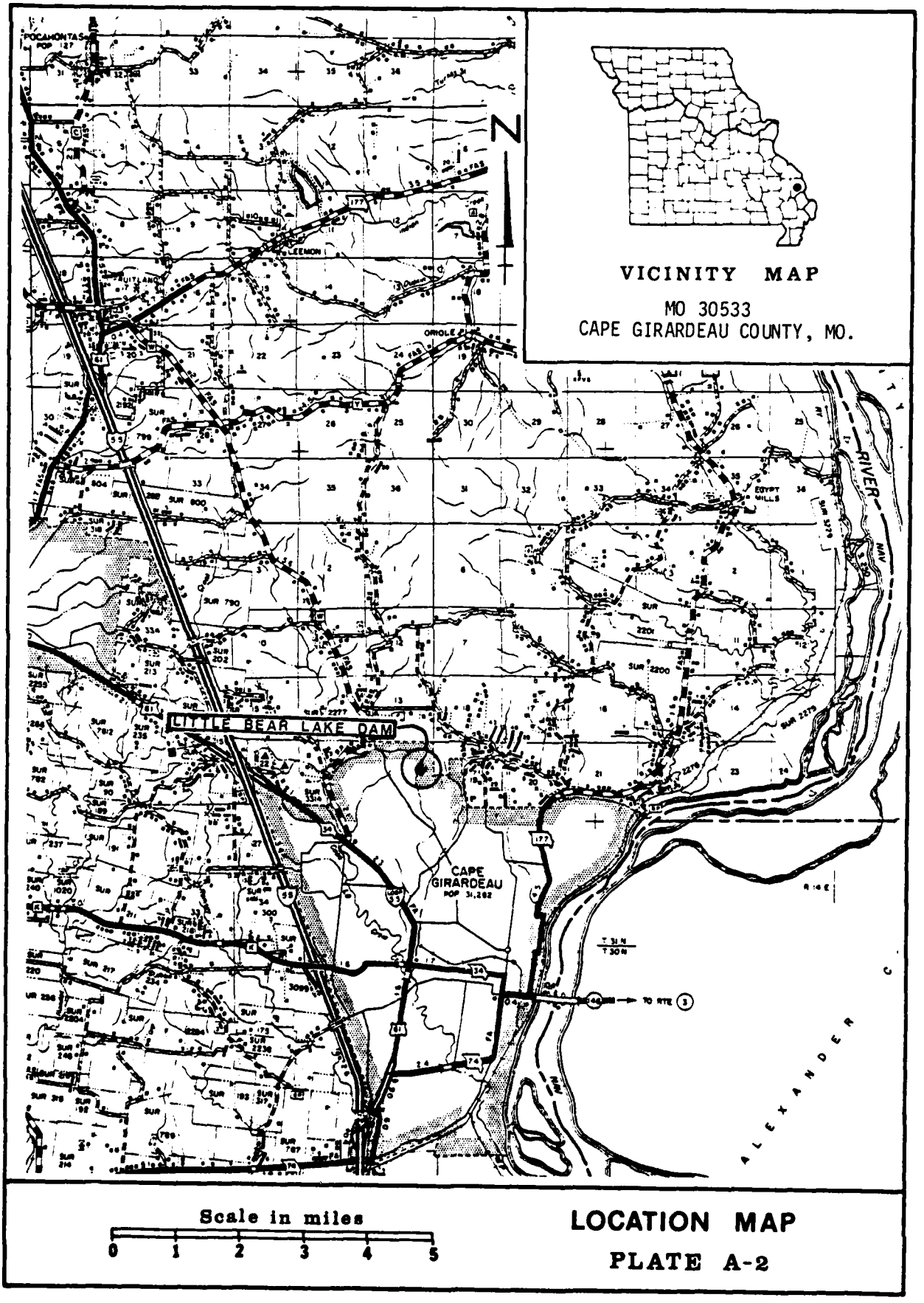
VICINITY TOPOGRAPHY

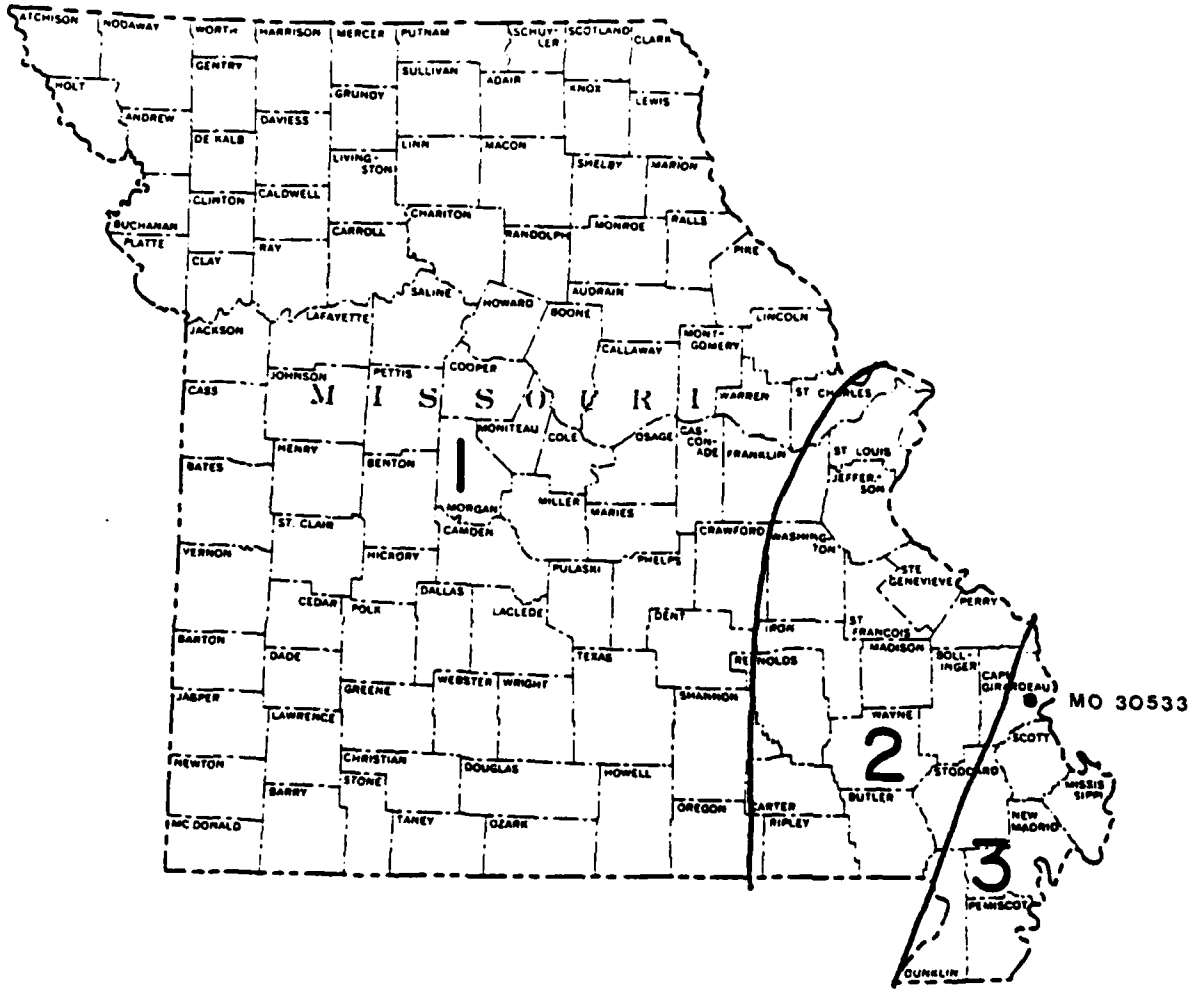
LITTLE BEAR LAKE DAM

CAPE GIRARDEAU COUNTY, MISSOURI

MO 30533

PLATE A-1

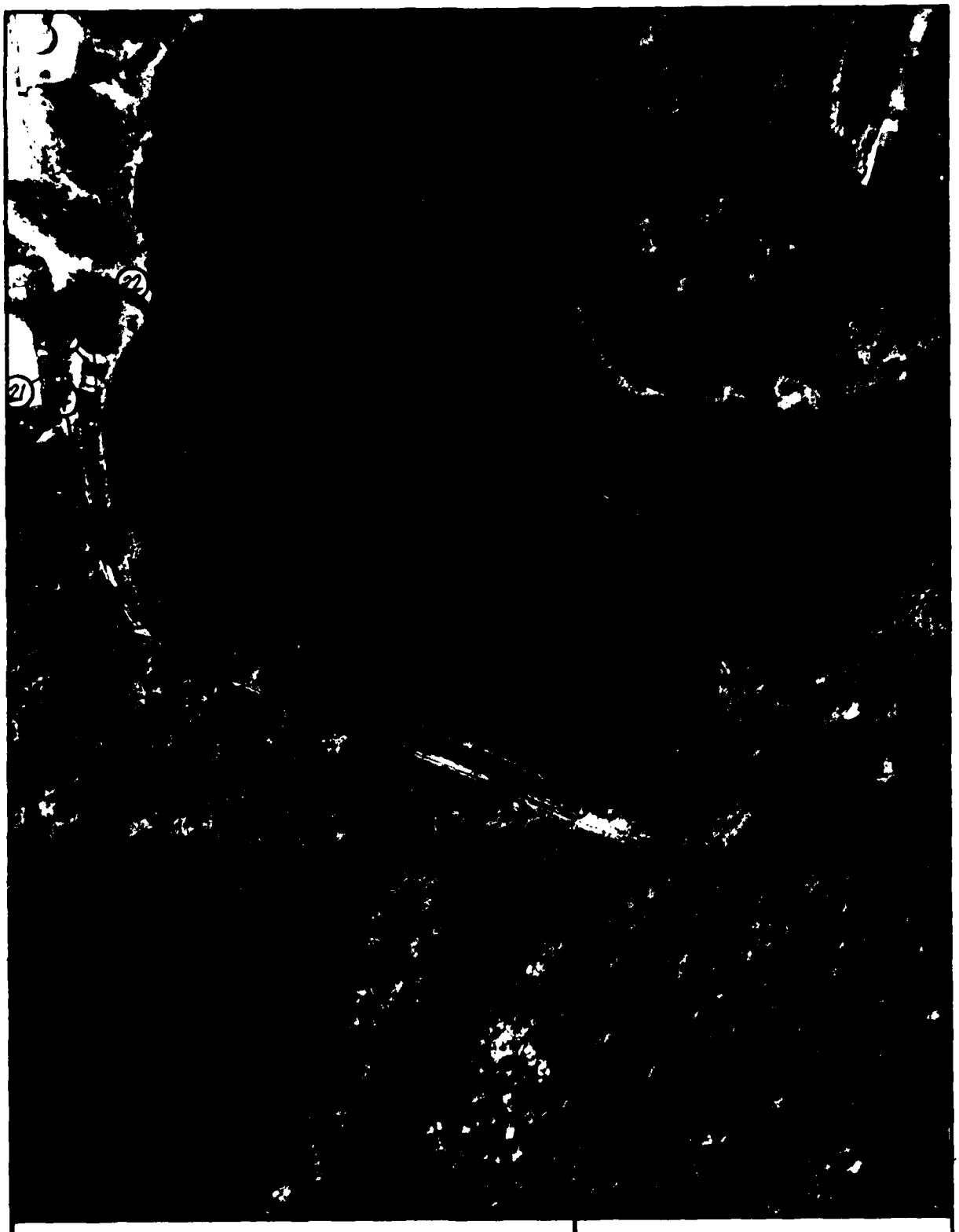

VICINITY MAP
MO 30533
CAPE GIRARDEAU COUNTY, MO.
N
LITTLE BEAR LAKE DAM
CAPE GIRARDEAU
POP 31,282
LEEMON
ORIOLE
EGYPT MILLS
MAY
RIVER
ALEXANDER
TO RTE 3
Scale in miles
0 1 2 3 4 5
LOCATION MAP
PLATE A-2



MISSOURI
SEISMIC ZONE MAP

PLATE A-3

APPENDIX B
PHOTOGRAPHS



LITTLE BEAR LAKE DAM
CAPE GIRARDEAU COUNTY, MISSOURI
MO. 30533

PHOTO INDEX

PLATE B-1

PHOTO NO. 2 - UPSTREAM SLOPE OF RIGHT LEG TAKEN FROM RIGHT END.

PHOTO NO. 3 - UPSTREAM SLOPE OF MAIN DAM TAKEN FROM LEFT END.

PHOTO NO. 4 - CREST OF RIGHT LEG.

PHOTO NO. 5 - CREST OF MAIN DAM FROM THE RIGHT SIDE.

PHOTO NO. 6 - CREST OF MAIN OR SOUTH DAM TAKEN FROM RIGHT END.

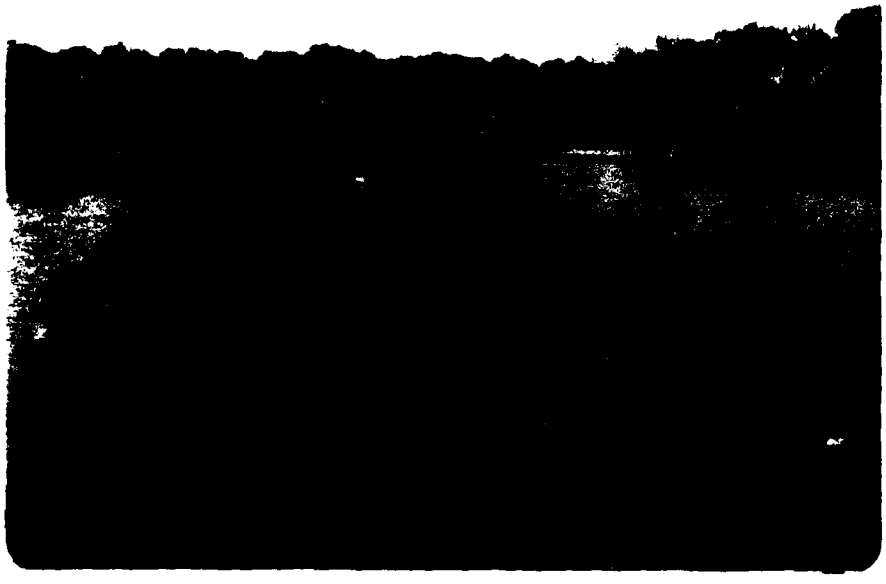


PHOTO NO. 7 - LOOKING UPSTREAM AT RESERVOIR FROM STA. 3+00.

PHOTO NO. 8 - LOOKING DOWNSTREAM FROM STA. 3+00.

PHOTO NO. 9 - DOWNSTREAM SLOPE OF RIGHT LEG.

PHOTO NO. 10 - DOWNSTREAM SLOPE TAKEN JUST DOWNSTREAM OF THE RIGHT LEG.

PHOTO NO. 11 - DOWNSTREAM SLOPE TAKEN FROM LEFT END.

PHOTO NO. 12 - INLET OF PRINCIPAL SPILLWAY AND UP-STREAM SLOPE.

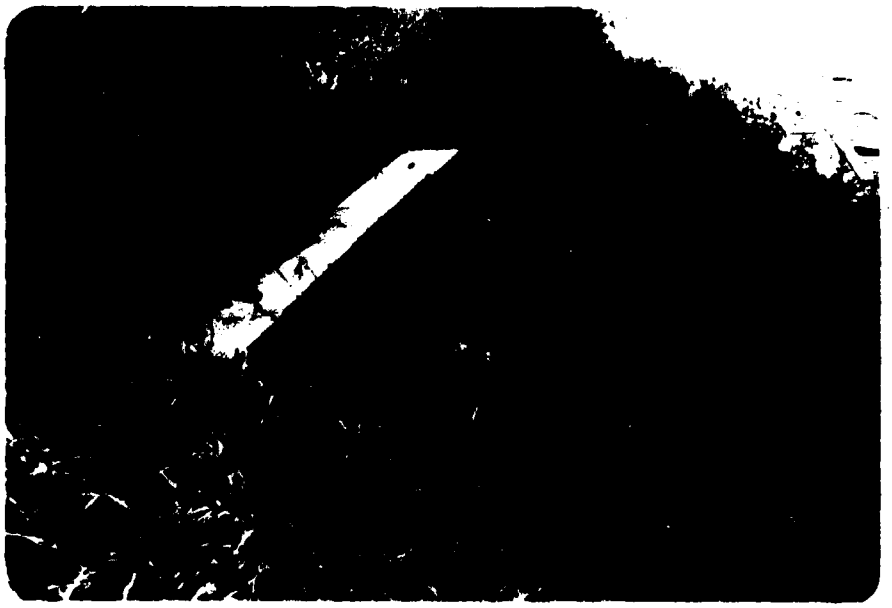


PHOTO NO. 13 - INLET OF PRINCIPAL SPILLWAY.

PHOTO NO. 14 - OUTLET OF THE PRINCIPAL SPILLWAY PIPE.
NOTE SMALL SEEP COMING OUT OF PIPE.

PHOTO NO. 15 - OUTLET OF
PRINCIPAL SPILLWAY PIPE
LOOKING UPSTREAM.

PHOTO NO. 16 - LOOKING DOWN-STREAM OVER THE PRINCIPAL SPILLWAY PIPE OUTLET.

PHOTO NO. 17 - SEEPAGE INTO THE CHANNEL BANK OF THE OLD CREEK ABOUT 10 FEET DOWNSTREAM FROM THE OUTLET.

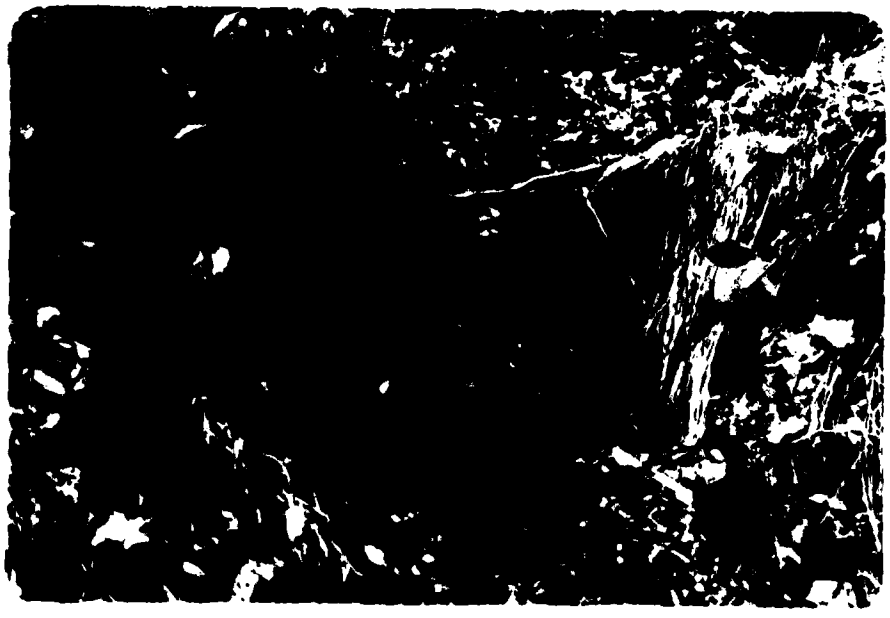


PHOTO NO. 18 - HEADCUT PROGRESSING UP NORTHWESTWARD ALONG THE TOE OF DAM. ABOUT 100 FEET RIGHT OF THE OUTLET OF SPILLWAY.

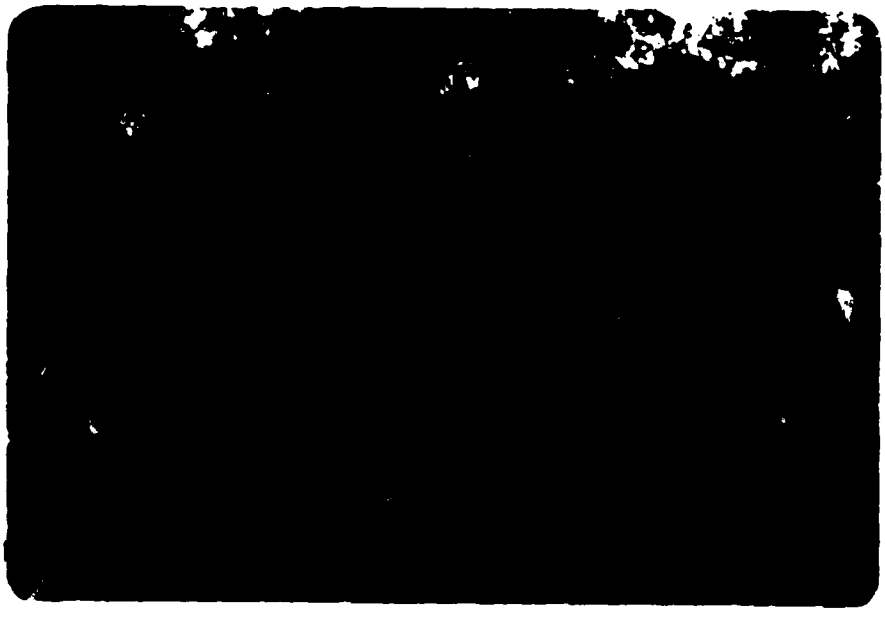


PHOTO NO. 19 - SEEPY SPOT DOWNSTREAM OF STA. 5+00.

PHOTO NO. 20 - SEWAGE LAGOON DOWNSTREAM OF THE DAM.

PHOTO NO. 21 - LOOKING UPSTREAM IN THE EMERGENCY SPILLWAY WHICH IS CUT THROUGH THE RIGHT ABUTMENT.

PHOTO NO. 22 - LOOKING DOWNSTREAM IN THE EMERGENCY SPILLWAY.

PHOTO NO. 23 - OVERVIEW FROM THE EMERGENCY SPILLWAY. UPSTREAM END OF SPILLWAY IS IN THE FOREGROUND.

PHOTO NO. 24 - OVERVIEW FROM UPSTREAM ON THE RIGHT SIDE.

PHOTO NO. 25 - OVERVIEW FROM UPSTREAM ON LEFT SIDE.

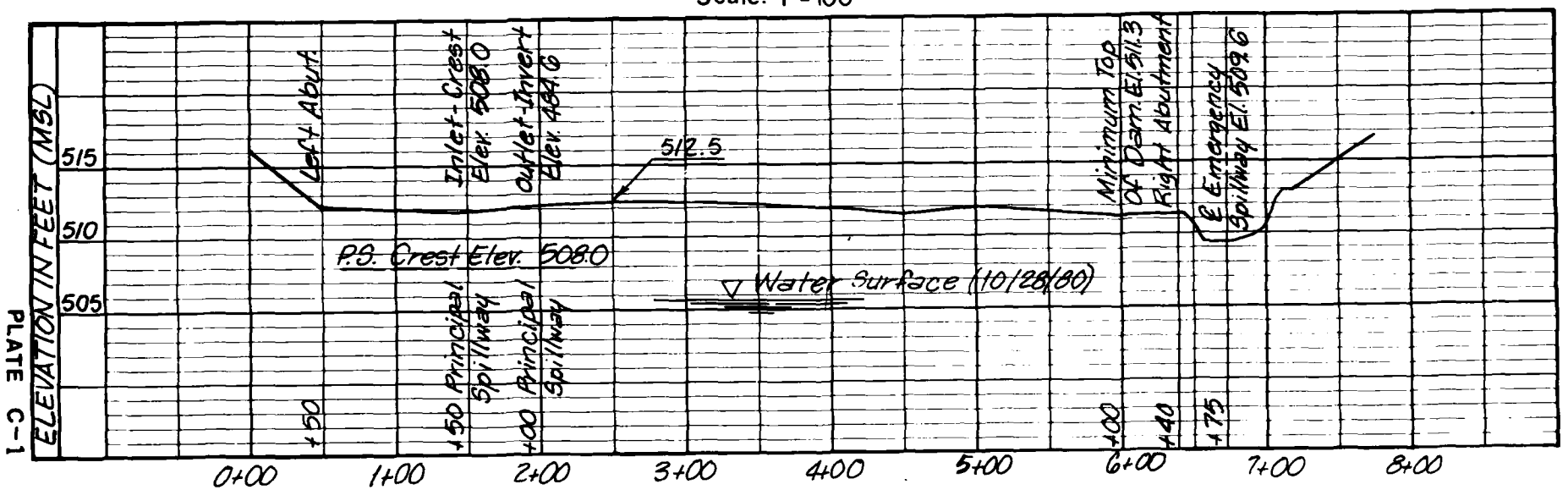
PHOTO NO. 26 - LOOKING NORTH AT HOUSE DIRECTLY SOUTH OF SEWAGE LAGOON AND DAM.

PHOTO NO. 27 - LOOKING SOUTHEAST AT DWELLING DIRECTLY SOUTH OF DWELLING SHOWN IN PHOTO NO. 26.

PHOTO NO. 28 - LOOKING SOUTH APPROX. 0.1 to 0.25 MILES DOWNSTREAM OF DAM AT NUMEROUS HOUSES IN POTENTIAL HAZARD AREA. CREEK IS TO THE LEFT OF PICTURE BEHIND THE HOUSES ON LEFT.

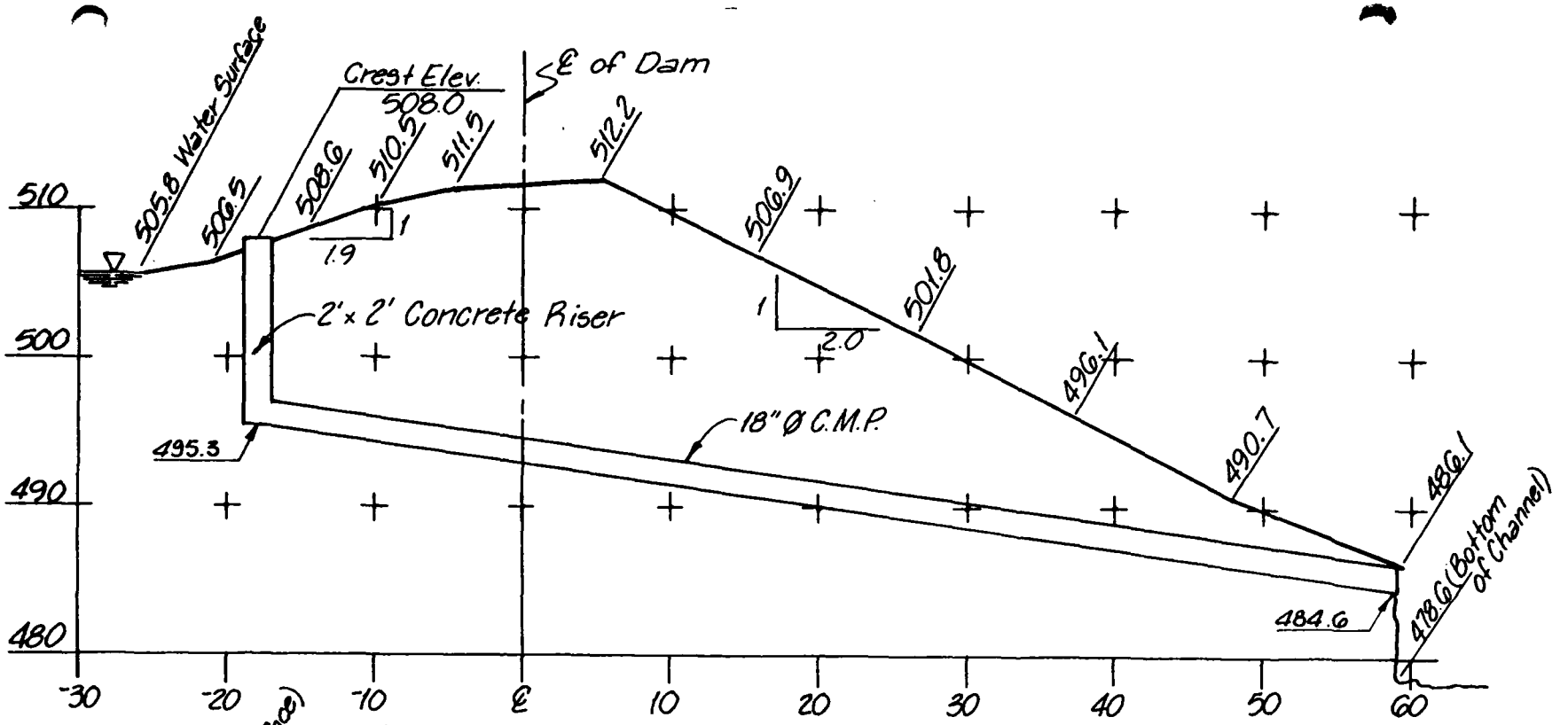
APPENDIX C
PROJECT PLATES

PLAN OF DAM
Scale: 1"= 100'



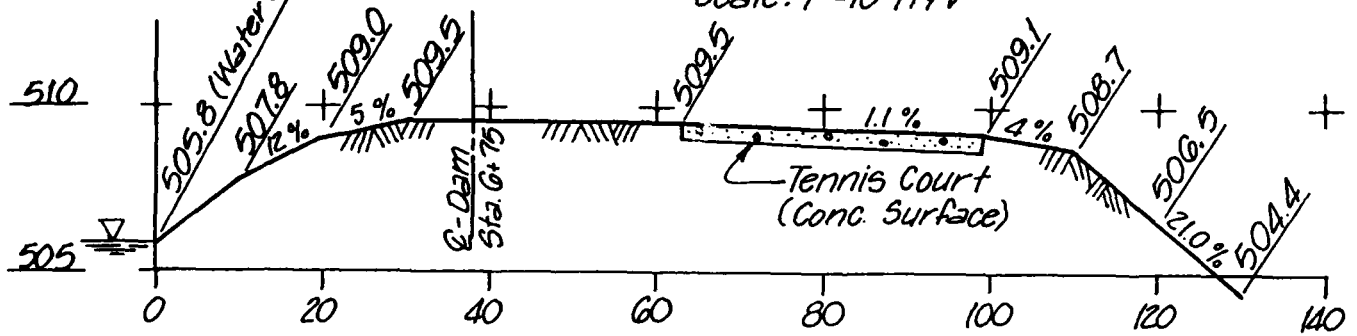
CENTERLINE PROFILE OF DAM
Scale As Shown

PLATE C-1



MAXIMUM CROSS-SECTION OF DAM AT STA. 1+50

Scale: 1"=10' H & V

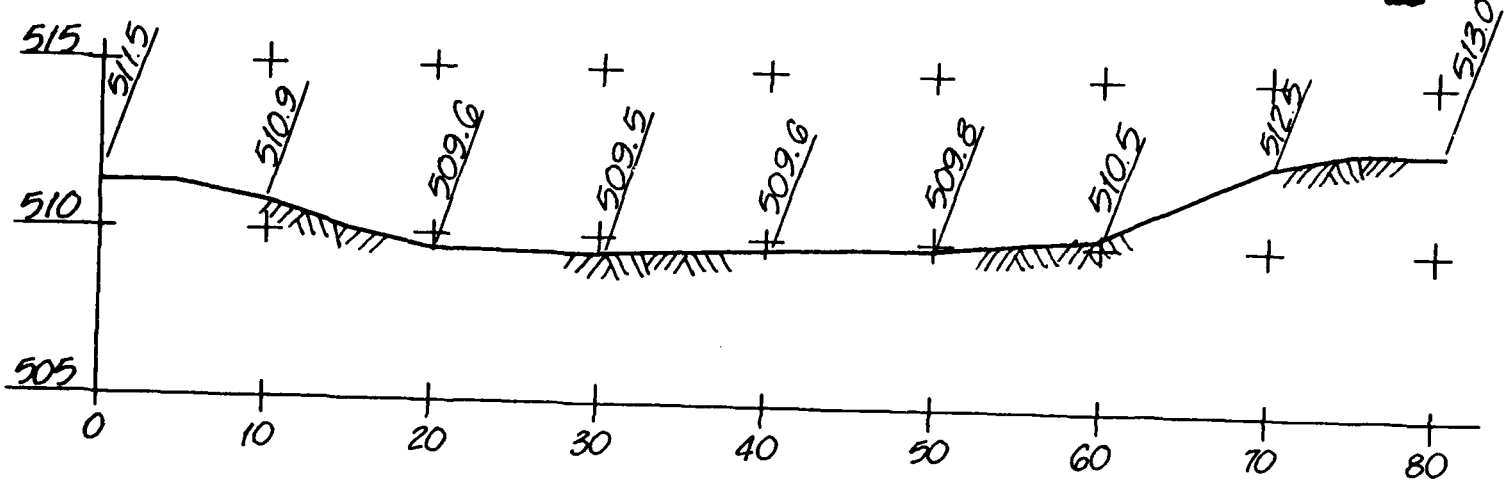


CENTERLINE PROFILE OF EMERGENCY SPILLWAY

Scale: 1"=20' H

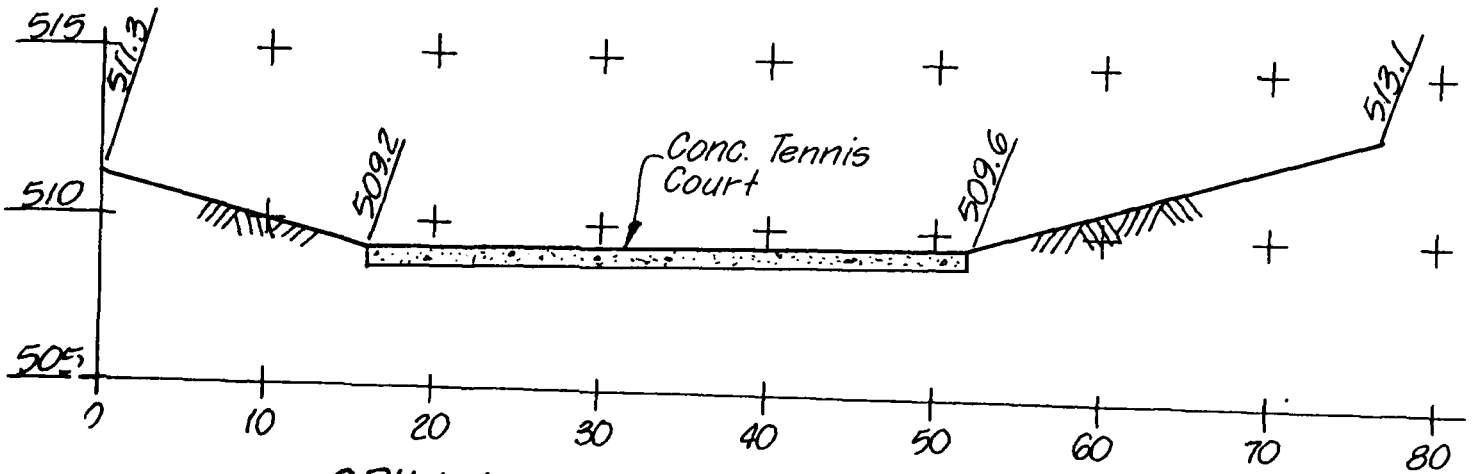
1"= 5' V

PLATE C-2



SPILLWAY CROSS-SECTION AT CENTERLINE OF DAM

Scale : 1" = 10' H
1" = 5' V



SPILLWAY CROSS-SECTION - 25' DOWNSTREAM OF CENTERLINE OF DAM

Scale: 1" = 10' H.
1" = 5' V.

PLATE C-3

APPENDIX D
HYDRAULIC AND HYDROLOGIC DATA

HYDROLOGIC COMPUTATIONS

1. The SCS dimensionless unit hydrograph and the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Corps of Engineers, Davis, California, were used to develop the inflow hydrographs (see this appendix).

   a. Twenty-four hour, one percent probabilistic rainfall for the dam location was taken from the data for the rainfall station at Cape Girardeau, Missouri, as supplied by the St. Louis District, Corps of Engineers per their letter dated 5 December 1980. The twenty-four hour probable maximum precipitation was taken from the curves of Hydrometeorological Report No. 33 and current Corps of Engineers and St. Louis policy and guidance for hydraulics and hydrology.

   b. Drainage area = 0.114 square miles (73 acres).

   c. Time of concentration of runoff = 15 minutes (computed from the "Kirpich" formula and verified using the equation from the California Culverts Practice, California Highways and Public Works Department).

   d. The antecedent storm conditions for the probable maximum precipitation were heavy rainfall and low temperatures which occurred on the previous 5 days (SCS AMC III). The antecedent storm conditions for the one percent probabilistic precipitation were an average of the conditions which have preceded the occurrence of the maximum annual flood on numerous watersheds (SCS AMC II). The initial pool elevation was assumed at the crest of the principal spillway.

   e. The total twenty-four hour storm duration losses for the one percent probabilistic storm were 4.32 inches. The total losses for the PMF storm were 3.17 inches. These data are based on SCS runoff curve No. 78 and No. 61 for antecedent moisture conditions SCS AMC III and AMC II respectively. The watershed is composed of primarily SCS soil groups Menfro and Clarksville (hydrologic soil group "B"). Heavy, thick woods cover the majority of the watershed area.

   f. Average soil loss rates = 0.13 inch per hour approximately.

2. The discharge ratings for the principal spillway were developed using equations for weir and full conduit flow. Orifice flow never controlled. The equations are as follows:

a. Weir flow equation ($Qw = CLH^{1.5}$)
where C = weir coefficient = 3.1 (from SCS Engr. Memo 50)
L = length of weir, ft. = 6.6
H = total head, ft. = pool elevation - 508.0

b. Full conduit flow equation

$$Q = a\sqrt{\frac{2gH}{1 + Kr + K_pL}}$$

where a = cross-sectional area of pipe, ft^2 = 1.77
H = total head, ft. = pool elevation - 485.5
K_r = coefficient for riser = 0.7 (SCS Design Note 8)
K_p = coefficient for pipe friction loss = 0.0674
(assuming "n" = 0.025, ES-42, SCS NEH, Section 5)
L = length of pipe, ft. = 90±

The emergency spillway discharge rating was developed using the Corps of Engineers Water Surface Profile HEC-2 computer program assuming critical depth approximately 47 ft. downstream of the control section.

The flows over the dam crest were developed using the HEC-1 (Dam Safety Version) program using the irregular top of dam option.

3. Floods were routed through the reservoir using the HEC-1 (Dam Safety Version) program to determine the capabilities of the spillway and dam embankment crest. The output and plotted hydrographs are shown in this Appendix.

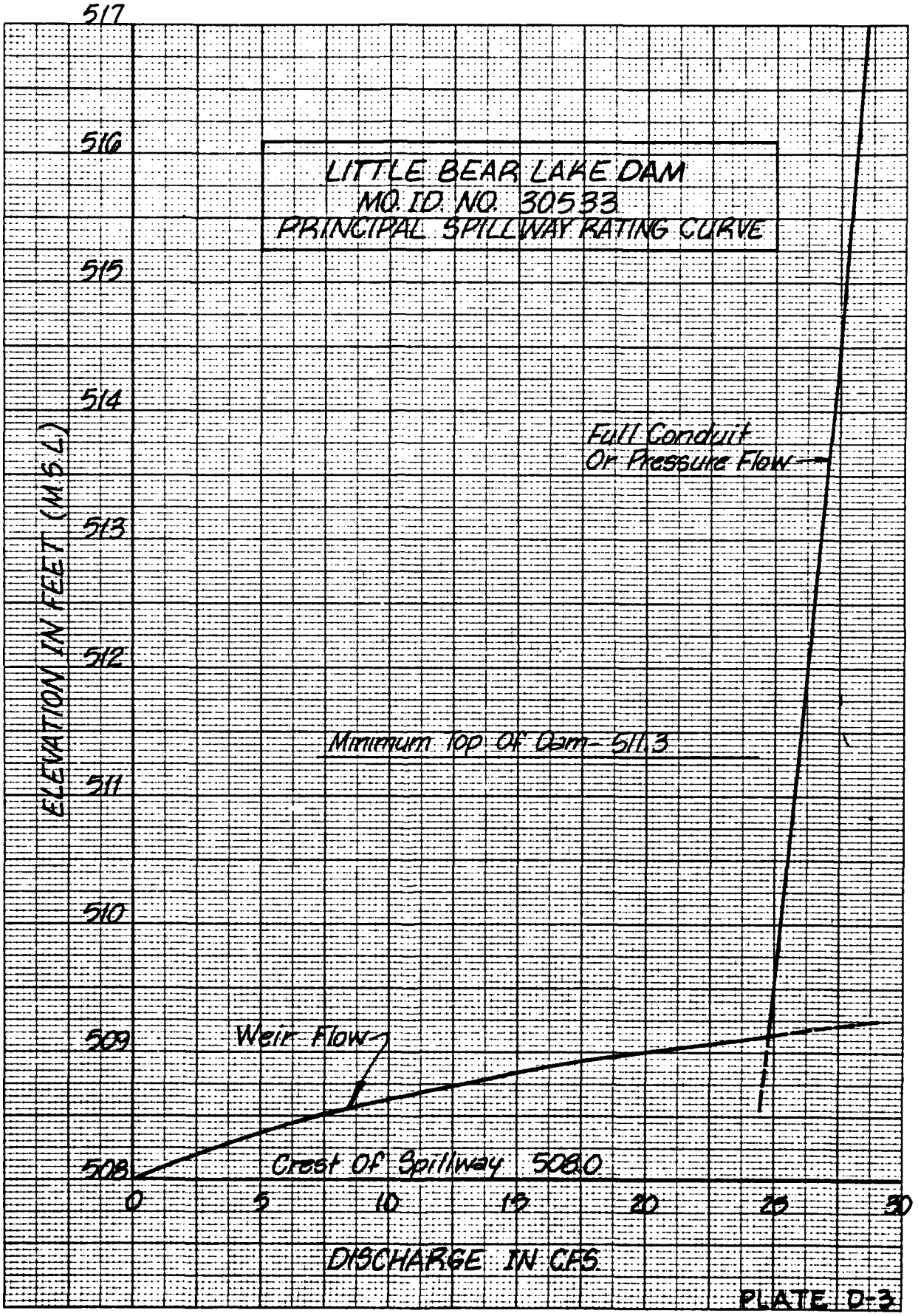


PLATE D-3

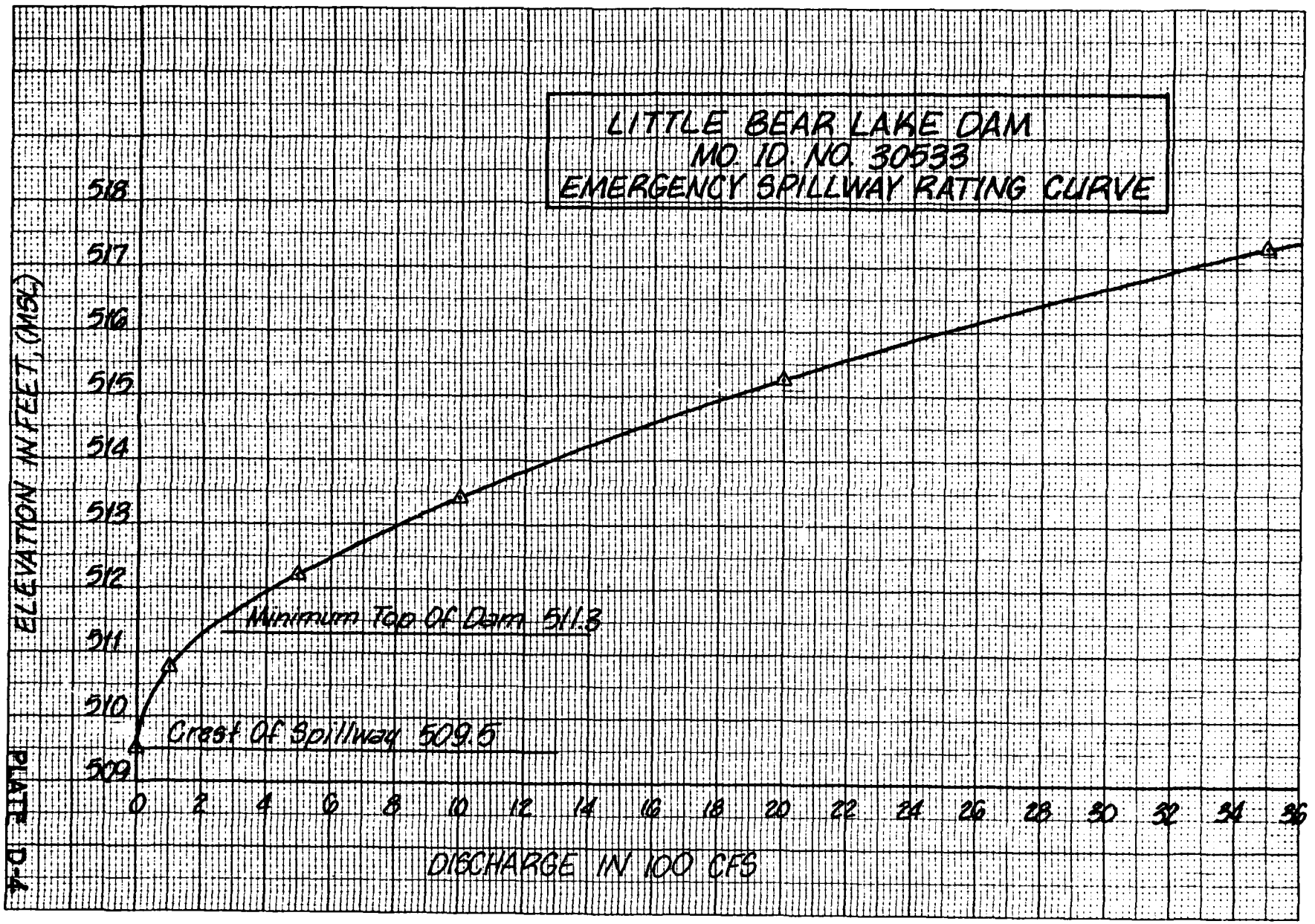
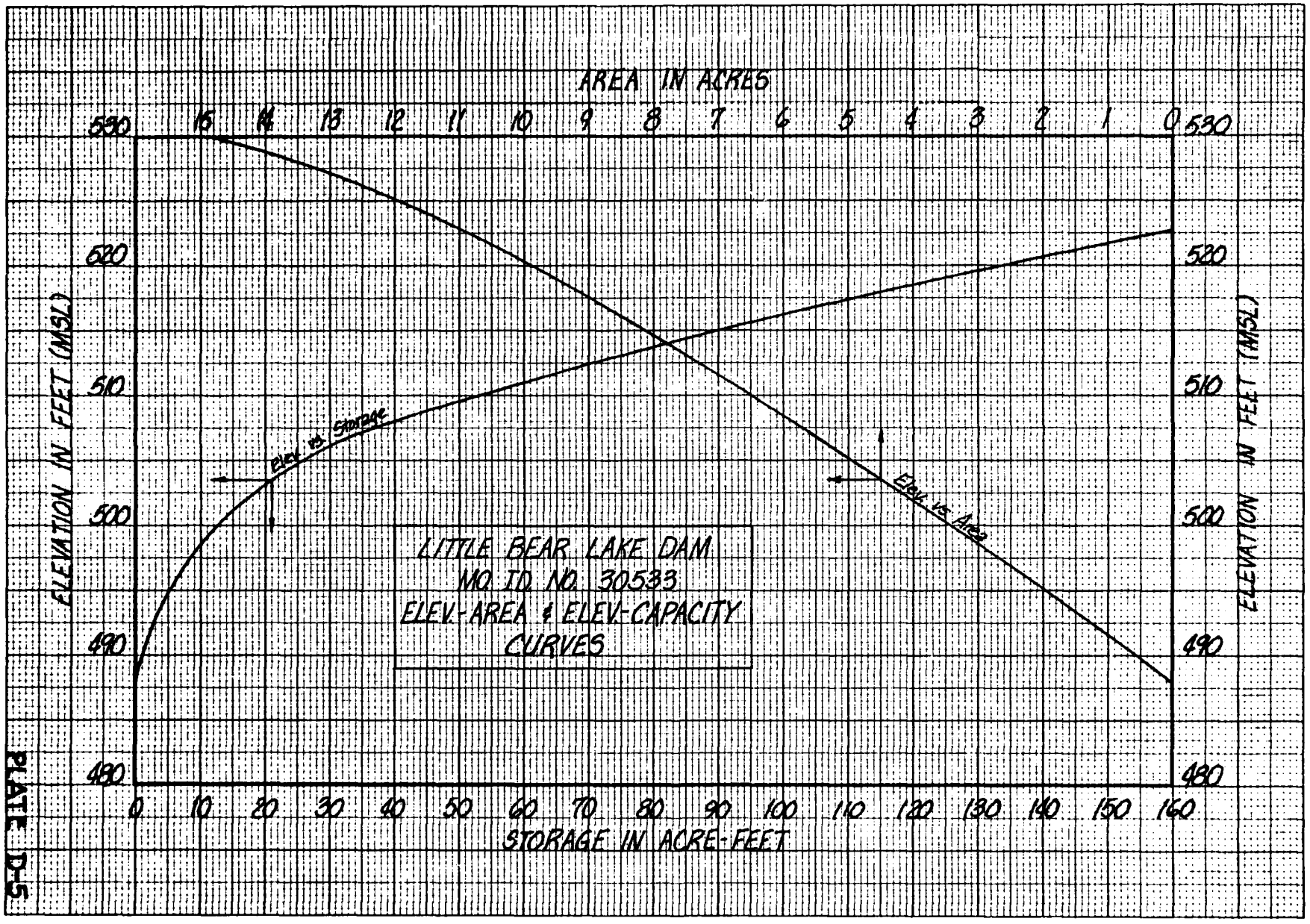


PLATE D-4



LISTING OF CARD INPUT DATA

```
A1                ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
A2                H X H ANALYSIS OF SAFETY OF LITTLE BEAR LAKE DAM-30533
A3                RATIOS OF PMF ROUTED THROUGH THE RESERVOIR
B 0002000000000000000005                                  000000000000000000000003
B1000005
J 000001000000900000001
J1000.1500000.2000000.2500000.3000000.3500000.4000000.4500000.50000001.0
K 00000000000001                                          000000000000000000000001
K1                CALCULATION OF INFLOW HYDROGRAPH TO RESERVOIR 30533
M 000001000000020000.114          0000.114000001.0                          00000001
P 000000000027.000000102000001210000130
T                                                                  -1.0    -78.0
W200000000000.17
X 000000     -.0100000001
K 00000100000002                                          000000020000000000000001
K1                ROUTED FLOWS THROUGH THE RESERVOIR 30533
Y                           000000100000001
Y1000001                                                          -508.0        -1
Y40508.0000508.5000509.0000509.5000510.0000510.5000511.0000511.5000512.0000512.5
Y40513.0000513.5000514.0000514.5000515.0000516.0000517.0
Y500000000000007000000210000002500000045000000860000016100000281000004360000061 7
Y500082700001047000012970000156800001858000024980000324 9
$A00000000005.9700009.8700014.92
$E0488.0000508.0000520.0000530.0
$$0508.0
$D0511.3000002.9000001.500000590
$L000000000000750000032500000407000004890000059500000600000006130000062500000640
$V0511.3000511.6000512.0000512.2000512.4000512.6000513.0000514.0000515.0000516.0
K 000099
A
A
A
A
A
```

PLATE D-6

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT 000001
ROUTE HYDROGRAPH TO 000002
END-OF-NETWORK

PLATE D-7

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  26 FEB 79
**********

RUN  DATE= 80/11/21.
     TIME= 09.05.52.

                    ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
                    H & H ANALYSIS OF SAFETY OF LITTLE BEAR LAKE DAM-30533
                    RATIOS OF PMF ROUTED THROUGH THE RESERVOIR

                                JOB SPECIFICATION
      NQ      NHR     NMIN     IDAY     IHR     IMIN     METRC     IPLT     IPRT     NSTAN
     288        0        5        0       0        0         0        0        3         0
                                JOPER     NWT   LROPT    TRACE
                                    5       0       0        0

                    MULTI-PLAN ANALYSES TO BE PERFORMED
                    NPLAN= 1 NRTIO= 9 LRTIO= 1
          RTIOS=     .15      .20      .25      .30      .35      .40      .45      .50     1.00

**********  **********  **********  **********  **********  **********

                    SUB-AREA RUNOFF COMPUTATION

                    CALCULATION OF INFLOW HYDROGRAPH TO RESERVOIR 30533

          ISTAQ   ICOMP   IECON   ITAPE   JPLT   JPRT   INAME   ISTAGE   IAUTO
         000001       0       0       0      0      0       1        0       0

                              HYDROGRAPH DATA
       IHYDG     IUHG    TAREA     SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
           1        2      .11     0.00     .11    1.00   0.000       0       1       0

                                PRECIP DATA
        SPFE      PMS       R6      R12      R24      R48      R72      R96
        0.00    27.00   102.00   121.00   130.00     0.00     0.00     0.00

                                LOSS DATA
       LROPT    STRKR    DLTKR    RTIOL    ERAIN    STRKS    RTIOK    STRTL    CNSTL    ALSMX    RTIMP
           0     0.00     0.00     1.00     0.00     0.00     1.00    -1.00   -78.00     0.00     0.00

     CURVE NO =   -78.00  WETNESS =    -1.00  EFFECT CN =    78.00

                            UNIT HYDROGRAPH DATA
                          TC=    0.00    LAG=     .17

                            RECESSION DATA
                     STRTQ=       0.00    QRCSN=      -.01    RTIOR= 1.00

     UNIT HYDROGRAPH 12 END OF PERIOD ORDINATES, TC=     0.00 HOURS, LAG=     .17  VOL= 1.00
          79.     239.     246.     154.      77.      41.      22.      11.       6.       3.
           2.       1.

                                END-OF-PERIOD FLOW
   0
 MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS   COMP Q   MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS   COMP Q
 1.01    .05       1    .01   0.00    .01       0.    1.01  12.05     145    .23    .20    .03      67.
 1.01    .10       2    .01   0.00    .01       0.    1.01  12.10     146    .23    .21    .02     101.
 1.01    .15       3    .01   0.00    .01       0.    1.01  12.15     147    .23    .21    .02     136.
 1.01    .20       4    .01   0.00    .01       0.    1.01  12.20     148    .23    .21    .02     158.
 1.01    .25       5    .01   0.00    .01       0.    1.01  12.25     149    .23    .21    .02     170.
 1.01    .30       6    .01   0.00    .01       0.    1.01  12.30     150    .23    .21    .02     177.
 1.01    .35       7    .01   0.00    .01       0.    1.01  12.35     151    .23    .21    .02     181.
 1.01    .40       8    .01   0.00    .01       0.    1.01  12.40     152    .23    .21    .02     183.
 1.01    .45       9    .01   0.00    .01       0.    1.01  12.45     153    .23    .21    .02     185.
 1.01    .50      10    .01   0.00    .01       0.    1.01  12.50     154    .23    .21    .02     186.
 1.01    .55      11    .01   0.00    .01       0.    1.01  12.55     155    .23    .21    .02     187.
 1.01   1.00      12    .01   0.00    .01       0.    1.01  13.00     156    .23    .21    .02     188.
 1.01   1.05      13    .01   0.00    .01       0.    1.01  13.05     157    .28    .26    .02     192.
 1.01   1.10      14    .01   0.00    .01       0.    1.01  13.10     158    .28    .26    .02     203.
 1.01   1.15      15    .01   0.00    .01       0.    1.01  13.15     159    .28    .26    .02     214.
 1.01   1.20      16    .01   0.00    .01       0.    1.01  13.20     160    .28    .26    .02     221.
 1.01   1.25      17    .01   0.00    .01       0.    1.01  13.25     161    .28    .26    .01     225.
 1.01   1.30      18    .01   0.00    .01       0.    1.01  13.30     162    .28    .26    .01     228.
 1.01   1.35      19    .01   0.00    .01       0.    1.01  13.35     163    .28    .26    .01     229.
 1.01   1.40      20    .01   0.00    .01       0.    1.01  13.40     164    .28    .26    .01     230.
```

PLATE D-8

PLATE D-9

1.01	9.10	110	.07	.05	.02	48.	1.01	21.10	254	.02	.02	.00	18.
1.01	9.15	111	.07	.06	.02	48.	1.01	21.15	255	.02	.02	.00	18.
1.01	9.20	112	.07	.06	.02	48.	1.01	21.20	256	.02	.02	.00	18.
1.01	9.25	113	.07	.06	.02	49.	1.01	21.25	257	.02	.02	.00	18.
1.01	9.30	114	.07	.06	.01	49.	1.01	21.30	258	.02	.02	.00	18.
1.01	9.35	115	.07	.06	.01	49.	1.01	21.35	259	.02	.02	.00	18.
1.01	9.40	116	.07	.06	.01	50.	1.01	21.40	260	.02	.02	.00	18.
1.01	9.45	117	.07	.06	.01	50.	1.01	21.45	261	.02	.02	.00	18.
1.01	9.50	118	.07	.06	.01	50.	1.01	21.50	262	.02	.02	.00	18.
1.01	9.55	119	.07	.06	.01	51.	1.01	21.55	263	.02	.02	.00	18.
1.01	10.00	120	.07	.06	.01	51.	1.01	22.00	264	.02	.02	.00	18.
1.01	10.05	121	.07	.06	.01	51.	1.01	22.05	265	.02	.02	.00	18.
1.01	10.10	122	.07	.06	.01	51.	1.01	22.10	266	.02	.02	.00	18.
1.01	10.15	123	.07	.06	.01	52.	1.01	22.15	267	.02	.02	.00	18.
1.01	10.20	124	.07	.06	.01	52.	1.01	22.20	268	.02	.02	.00	18.
1.01	10.25	125	.07	.06	.01	52.	1.01	22.25	269	.02	.02	.00	18.
1.01	10.30	126	.07	.06	.01	52.	1.01	22.30	270	.02	.02	.00	18.
1.01	10.35	127	.07	.06	.01	52.	1.01	22.35	271	.02	.02	.00	18.
1.01	10.40	128	.07	.06	.01	53.	1.01	22.40	272	.02	.02	.00	18.
1.01	10.45	129	.07	.06	.01	53.	1.01	22.45	273	.02	.02	.00	18.
1.01	10.50	130	.07	.06	.01	53.	1.01	22.50	274	.02	.02	.00	18.
1.01	10.55	131	.07	.06	.01	53.	1.01	22.55	275	.02	.02	.00	18.
1.01	11.00	132	.07	.06	.01	53.	1.01	23.00	276	.02	.02	.00	18.
1.01	11.05	133	.07	.06	.01	54.	1.01	23.05	277	.02	.02	.00	18.
1.01	11.10	134	.07	.06	.01	54.	1.01	23.10	278	.02	.02	.00	18.
1.01	11.15	135	.07	.06	.01	54.	1.01	23.15	279	.02	.02	.00	18.
1.01	11.20	136	.07	.06	.01	54.	1.01	23.20	280	.02	.02	.00	18.
1.01	11.25	137	.07	.06	.01	54.	1.01	23.25	281	.02	.02	.00	18.
1.01	11.30	138	.07	.06	.01	54.	1.01	23.30	282	.02	.02	.00	18.
1.01	11.35	139	.07	.06	.01	55.	1.01	23.35	283	.02	.02	.00	18.
1.01	11.40	140	.07	.06	.01	55.	1.01	23.40	284	.02	.02	.00	18.
1.01	11.45	141	.07	.06	.01	55.	1.01	23.45	285	.02	.02	.00	18.
1.01	11.50	142	.07	.06	.01	55.	1.01	23.50	286	.02	.02	.00	18.
1.01	11.55	143	.07	.06	.01	55.	1.01	23.55	287	.02	.02	.00	18.
1.01	12.00	144	.07	.06	.01	55.	1.02	0.00	288	.02	.02	.00	18.
									SUM	35.10	31.93	3.17	28150.
										(892.)	(811.)	(81.)	(797.12)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1408.	326.	98.	98.	28123.
CMS	40.	9.	3.	3.	796.
INCHES		26.56	31.87	31.87	31.87
MM		674.66	809.55	809.55	809.55
AC-FT		161.	194.	194.	194.
THOUS CU M		199.	239.	239.	239.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	211.	49.	15.	15.	4218.
CMS	6.	1.	0.	0.	119.
INCHES		3.98	4.78	4.78	4.78
MM		101.20	121.43	121.43	121.43
AC-FT		24.	29.	29.	29.
THOUS CU M		30.	36.	36.	36.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 2

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	282.	65.	20.	20.	5625.
CMS	8.	2.	1.	1.	159.
INCHES		5.31	6.37	6.37	6.37
MM		134.93	161.91	161.91	161.91
AC-FT		32.	39.	39.	39.
THOUS CU M		40.	48.	48.	48.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 3

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	352.	81.	24.	24.	7031.
CMS	10.	2.	1.	1.	199.
INCHES		6.64	7.97	7.97	7.97
MM		168.67	202.39	202.39	202.39
AC-FT		40.	48.	48.	48.
THOUS CU M		50.	60.	60.	60.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 4

PLATE D-10

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	422.	98.	29.	29.	8437.
CMS	12.	3.	1.	1.	239.
INCHES		7.97	9.56	9.56	9.56
MM		202.40	242.87	242.87	242.87
AC-FT		48.	58.	58.	58.
THOUS CU M		60.	72.	72.	72.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 5

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	493.	114.	34.	34.	9843.
CMS	14.	3.	1.	1.	279.
INCHES		9.30	11.16	11.16	11.16
MM		236.14	283.34	283.34	283.34
AC-FT		56.	68.	68.	68.
THOUS CU M		70.	84.	84.	84.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 6

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	563.	130.	39.	39.	11249.
CMS	16.	4.	1.	1.	319.
INCHES		10.62	12.75	12.75	12.75
MM		269.87	323.82	323.82	323.82
AC-FT		65.	77.	77.	77.
THOUS CU M		80.	96.	96.	96.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 7

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	634.	146.	44.	44.	12655.
CMS	18.	4.	1.	1.	358.
INCHES		11.95	14.34	14.34	14.34
MM		303.60	364.30	364.30	364.30
AC-FT		73.	87.	87.	87.
THOUS CU M		90.	108.	108.	108.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 8

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	704.	163.	49.	49.	14061.
CMS	20.	5.	1.	1.	398.
INCHES		13.28	15.94	15.94	15.94
MM		337.33	404.78	404.78	404.78
AC-FT		81.	97.	97.	97.
THOUS CU M		100.	119.	119.	119.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 9

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1408.	326.	98.	98.	28123.
CMS	40.	9.	3.	3.	796.
INCHES		26.56	31.87	31.87	31.87
MM		674.66	809.55	809.55	809.55
AC-FT		161.	194.	194.	194.
THOUS CU M		199.	239.	239.	239.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTED FLOWS THROUGH THE RESERVOIR 30533

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
000002	1	0	0	2	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-508.	-1

STAGE	508.00	508.50	509.00	509.50	510.00	510.50	511.00	511.50	512.00	512.50

PLATE D-11

FLOW	0.00	7.00	21.00	25.00	45.00	86.00	161.00	281.00	436.00	617.00
	827.00	1047.00	1297.00	1568.00	1858.00	2498.00	3249.00			
SURFACE AREA=	0.	6.	10.	15.						
CAPACITY=	0.	40.	134.	257.						
ELEVATION=	488.	508.	520.	530.						

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
508.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
511.3	2.9	1.5	590.

CREST LENGTH	0.	75.	325.	407.	489.	595.	600.	613.	625.	640.
AT OR BELOW ELEVATION	511.3	511.6	512.0	512.2	512.4	512.6	513.0	514.0	515.0	516.0

STATION 000002, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	2.	2.	2.
2.	2.	2.	2.	2.	2.	2.	2.	2.	2.
3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
3.	3.	3.	3.	4.	4.	4.	4.	4.	4.
4.	4.	4.	4.	4.	4.	4.	4.	4.	4.
5.	5.	5.	5.	5.	5.	5.	5.	6.	6.
6.	7.	7.	8.	8.	9.	9.	10.	11.	11.
12.	13.	13.	14.	15.	15.	16.	17.	17.	18.
18.	19.	20.	20.	21.	21.	21.	22.	22.	22.
22.	22.	23.	23.	23.	24.	24.	28.	36.	42.
48.	54.	56.	58.	58.	57.	56.	55.	54.	53.
52.	52.	51.	50.	49.	49.	48.	47.	46.	45.
44.	44.	44.	43.	43.	42.	42.	41.	40.	39.
38.	36.	35.	34.	32.	31.	30.	29.	28.	27.
26.	25.	25.	25.	24.	24.	24.	24.	24.	23.
23.	23.	23.	23.	23.	22.	22.	22.	22.	22.
22.	21.	21.	21.	21.	20.	20.	19.	19.	18.
18.	17.	17.	16.	16.	15.	15.	15.	14.	14.
14.	13.	13.	13.	12.	12.	12.	11.	11.	11.
11.	10.	10.	10.	10.	10.	9.	9.		

STORAGE

40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	41.
41.	41.	41.	41.	41.	41.	41.	41.	41.	41.
41.	41.	41.	41.	41.	41.	41.	41.	41.	41.
41.	41.	41.	41.	41.	41.	41.	41.	41.	41.
41.	42.	42.	42.	42.	42.	42.	42.	42.	42.
42.	42.	42.	42.	42.	42.	42.	42.	42.	42.
43.	43.	43.	43.	43.	43.	43.	43.	44.	44.
44.	44.	44.	44.	45.	45.	45.	45.	45.	45.
45.	45.	46.	46.	46.	46.	46.	46.	47.	47.
47.	47.	47.	47.	48.	48.	49.	50.	51.	52.
53.	53.	53.	53.	53.	53.	53.	53.	53.	53.
53.	53.	53.	53.	53.	53.	53.	52.	52.	52.
52.	52.	52.	52.	52.	52.	52.	52.	52.	51.
51.	51.	51.	50.	50.	50.	50.	50.	50.	49.
49.	49.	49.	49.	49.	48.	48.	48.	48.	48.
48.	48.	47.	47.	47.	47.	47.	47.	47.	46.
46.	46.	46.	46.	46.	46.	46.	45.	45.	45.
45.	45.	45.	45.	45.	45.	45.	45.	44.	44.
44.	44.	44.	44.	44.	44.	44.	44.	44.	44.
44.	44.	44.	43.	43.	43.	43.	43.		

OVN

STATION 000002, PLAN 1, RATIO 3 0.25 PMF

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	2.
2.	2.	2.	2.	2.	2.	2.	3.	3.	3.
3.	3.	3.	3.	3.	4.	4.	4.	4.	4.
4.	4.	4.	5.	5.	5.	5.	5.	5.	5.
5.	6.	6.	6.	6.	6.	6.	6.	6.	6.
7.	7.	7.	7.	7.	7.	7.	8.	8.	8.
8.	8.	8.	9.	9.	9.	10.	11.	12.	13.
14.	15.	15.	16.	17.	18.	19.	20.	21.	21.
22.	22.	22.	23.	23.	23.	23.	24.	24.	24.
25.	25.	27.	29.	31.	33.	35.	36.	38.	39.
41.	42.	43.	44.	48.	54.	66.	84.	121.	149.
164.	170.	165.	157.	148.	139.	131.	123.	116.	109.
104.	99.	95.	91.	88.	86.	84.	82.	80.	78.
76.	74.	73.	72.	70.	69.	68.	66.	63.	59.
55.	51.	48.	45.	43.	41.	40.	38.	37.	36.
34.	33.	32.	31.	30.	29.	28.	27.	26.	25.
25.	25.	24.	24.	24.	24.	24.	24.	23.	23.
23.	23.	23.	23.	22.	22.	22.	22.	22.	22.
22.	21.	21.	21.	21.	20.	20.	19.	19.	18.
18.	18.	17.	17.	16.	16.	16.	15.	15.	15.
14.	14.	14.	14.	13.	13.	13.	12.		

STORAGE

40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
41.	41.	41.	41.	41.	41.	41.	41.	41.	41.
41.	41.	41.	41.	41.	41.	41.	41.	42.	42.
42.	42.	42.	42.	42.	42.	42.	42.	42.	42.
42.	42.	42.	42.	42.	42.	42.	42.	43.	43.
43.	43.	43.	43.	43.	43.	43.	43.	43.	43.
43.	43.	43.	43.	43.	43.	43.	44.	44.	44.
44.	44	45.	45.	45.	45.	45.	46.	46.	46.
46.	47.	47.	47.	47.	48.	48.	48.	48.	49.
49.	49.	49.	50.	50.	50.	51.	51.	51.	51.
52.	52.	52.	52.	53.	53.	54.	56.	57.	58.
59.	59.	59.	59.	58.	58.	58.	57.	57.	57.
56.	56.	56.	56.	56.	56.	55.	55.	55.	55.
55.	55.	55.	54.	54.	54.	54.	54.	54.	53.
53.	53.	53.	52.	52.	52.	51.	51.	51.	51.
51.	50.	50.	50.	50.	50.	49.	49.	49.	49.
49.	49.	49.	48.	48.	48.	48.	48.	48.	48.
48.	47.	47.	47.	47.	47.	47.	47.	47.	46.
46.	46.	46.	46.	46.	46.	46.	46.	45.	45.
45.	45.	45.	45.	45.	45.	45.	45.	45.	45.
44.	44.	44.	44.	44.	44.	44.	44.		

STAGE

508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0
508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0
508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0
508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0
508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0
508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0
508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0
508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0
508.0	508.1	508.1	508.1	508.1	508.1	508.1	508.1	508.1	508.1
508.1	508.1	508.1	508.1	508.2	508.2	508.2	508.2	508.2	508.2
508.2	508.2	508.2	508.2	508.2	508.3	508.3	508.3	508.3	508.3
508.3	508.3	508.3	508.3	508.3	508.3	508.4	508.4	508.4	508.4
508.4	508.4	508.4	508.4	508.4	508.4	508.4	508.4	508.5	508.5
508.5	508.5	508.5	508.5	508.5	508.5	508.5	508.5	508.5	508.5
508.5	508.5	508.6	508.6	508.6	508.6	508.6	508.6	508.7	508.7

509.1	509.1	509.2	509.2	509.2	509.3	509.3	509.3	509.4	509.4
509.5	509.5	509.6	509.6	509.7	509.7	509.7	509.8	509.8	509.9
509.9	509.9	509.9	510.0	510.0	510.1	510.3	510.5	510.7	510.9
511.0	511.0	511.0	511.0	510.9	510.9	510.8	510.7	510.7	510.7
510.6	510.6	510.6	510.5	510.5	510.5	510.5	510.4	510.4	510.4
510.4	510.4	510.3	510.3	510.3	510.3	510.3	510.3	510.2	510.2
510.1	510.1	510.0	510.0	509.9	509.9	509.9	509.8	509.8	509.8
509.7	509.7	509.7	509.6	509.6	509.6	509.6	509.5	509.5	509.5
509.5	509.5	509.4	509.4	509.4	509.4	509.3	509.3	509.3	509.3
509.3	509.2	509.2	509.2	509.2	509.2	509.1	509.1	509.1	509.1
509.1	509.0	509.0	509.0	509.0	509.0	509.0	508.9	508.9	508.9
508.9	508.9	508.9	508.9	508.8	508.8	508.8	508.8	508.8	508.8
508.8	508.8	508.7	508.7	508.7	508.7	508.7	508.7		

PEAK OUTFLOW IS 170. AT TIME 16.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	170.	66.	22.	22.	6422.
CMS	5.	2.	1.	1.	182.
INCHES		5.42	7.28	7.28	7.28
MM		137.73	184.85	184.85	184.85
AC-FT		33.	44.	44.	44.
THOUS CU M		41.	55.	55.	55.

PLATE D-14

OVF

STATION000002

INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)

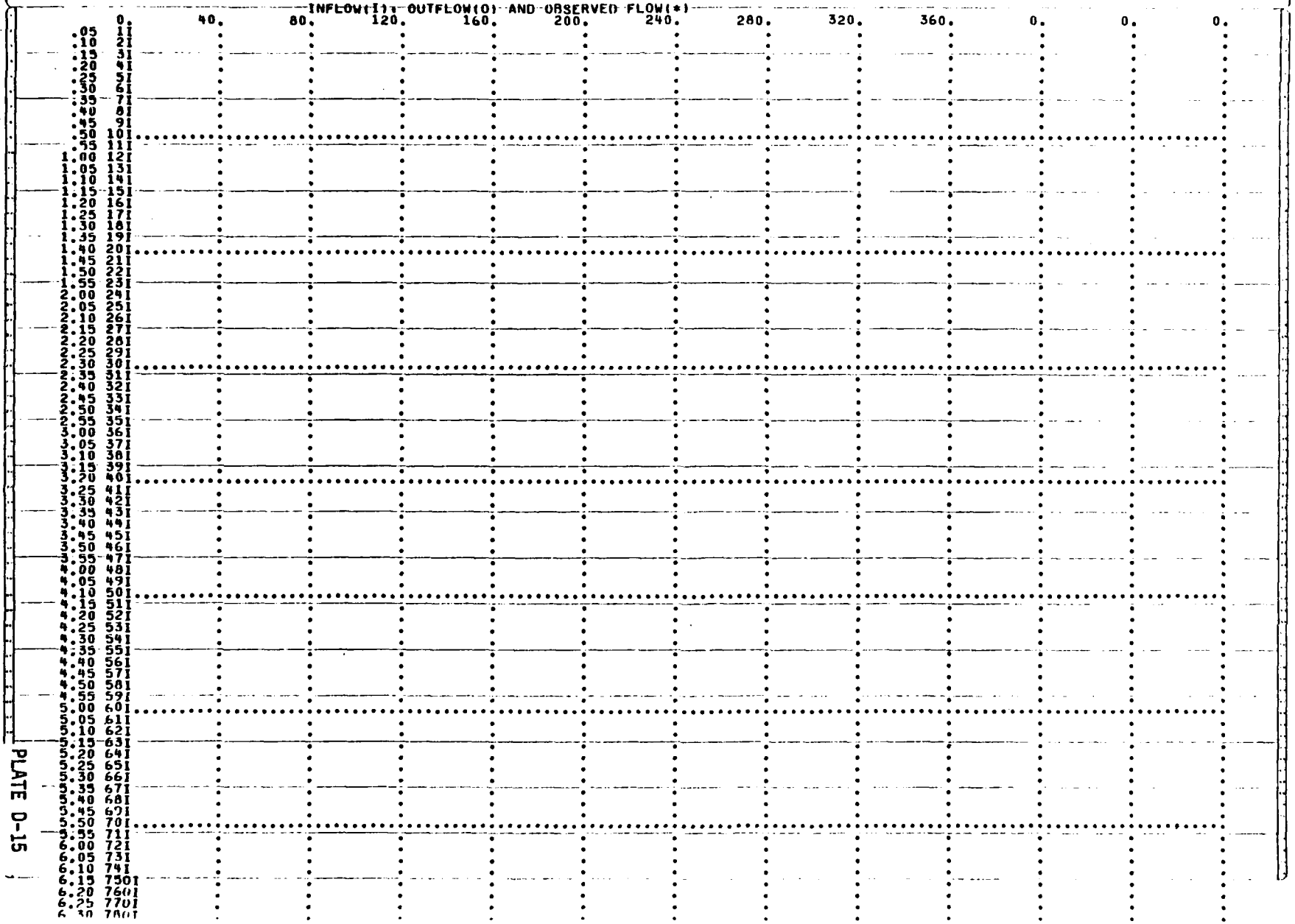


PLATE D-15

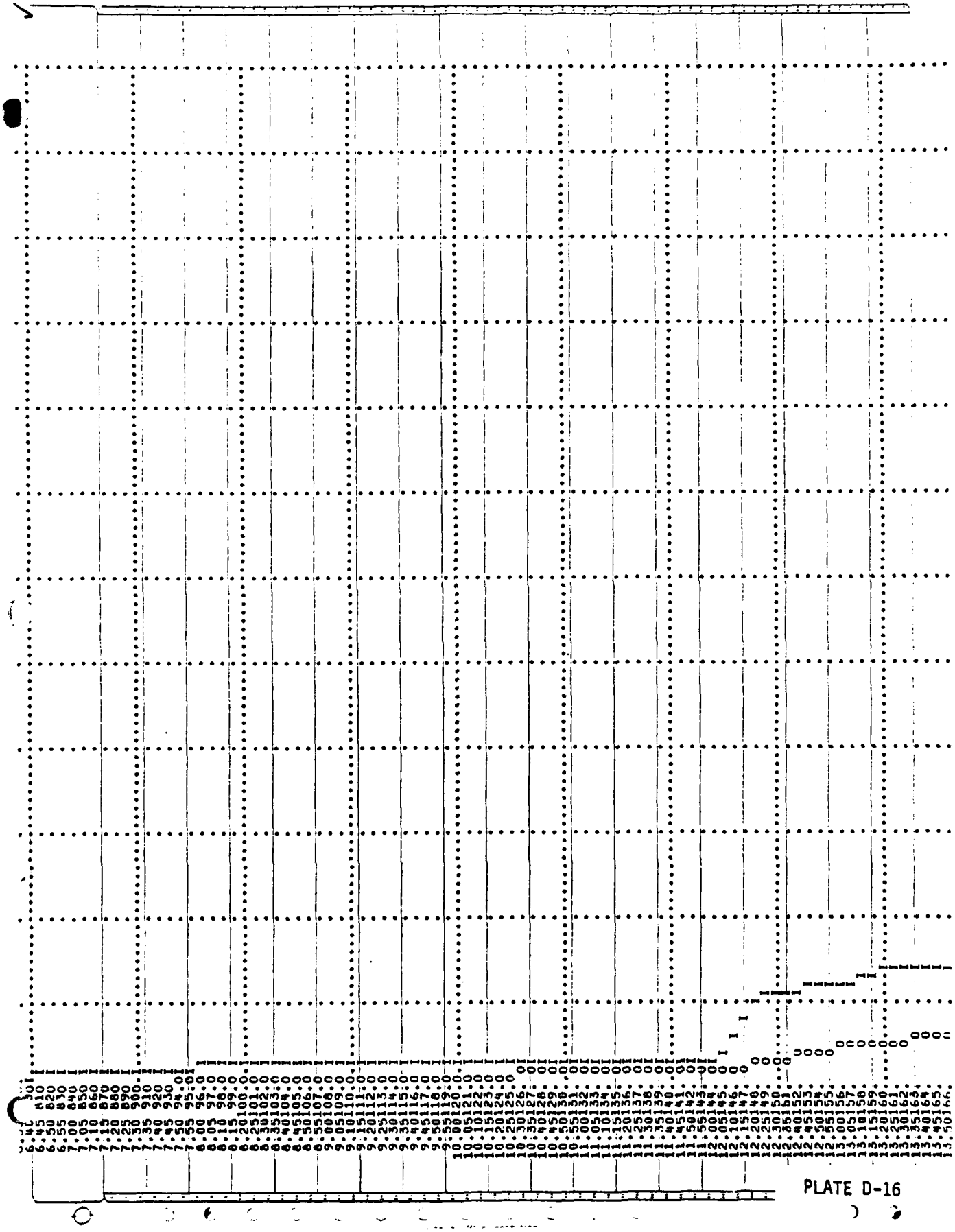


PLATE D-16

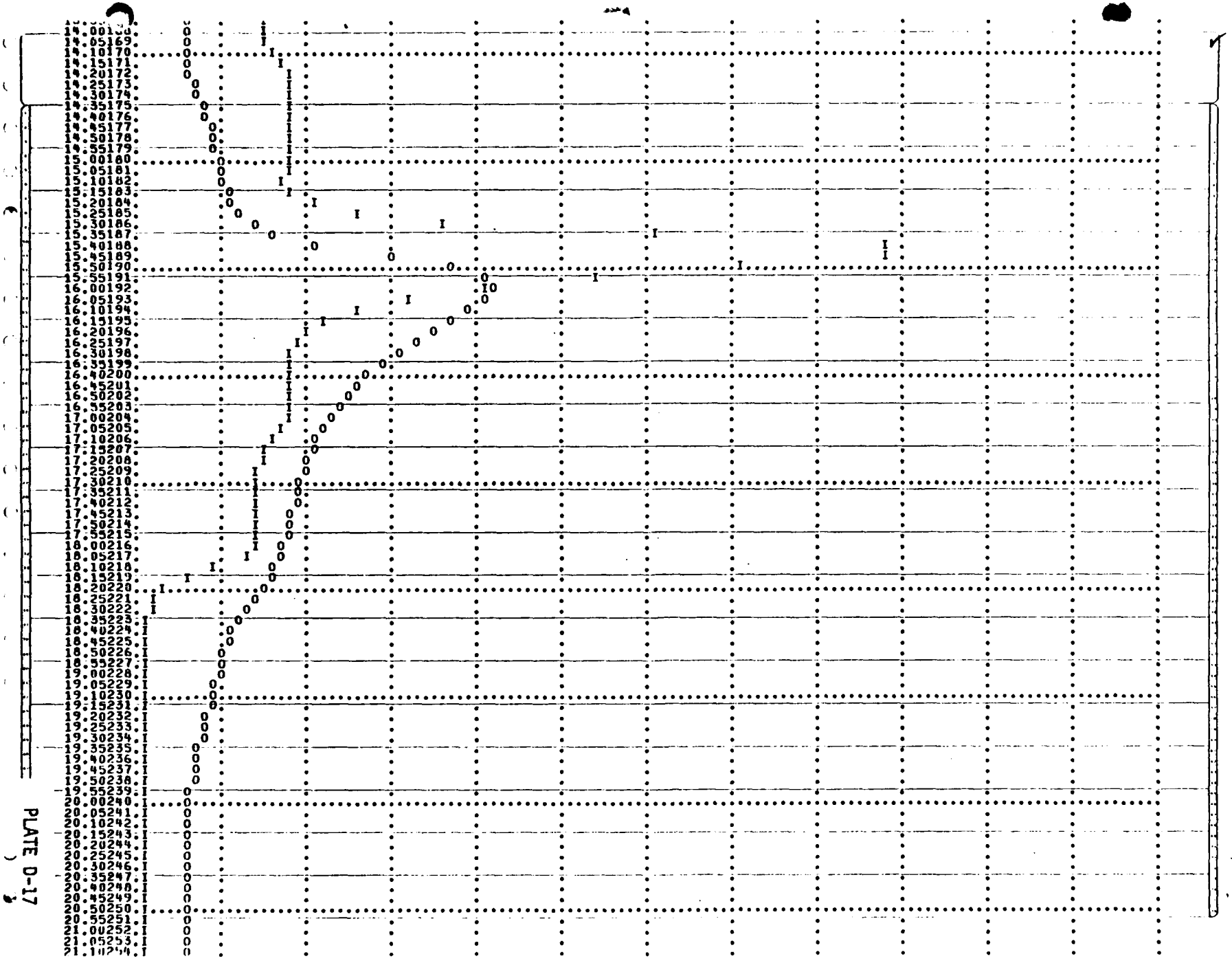


PLATE D-17

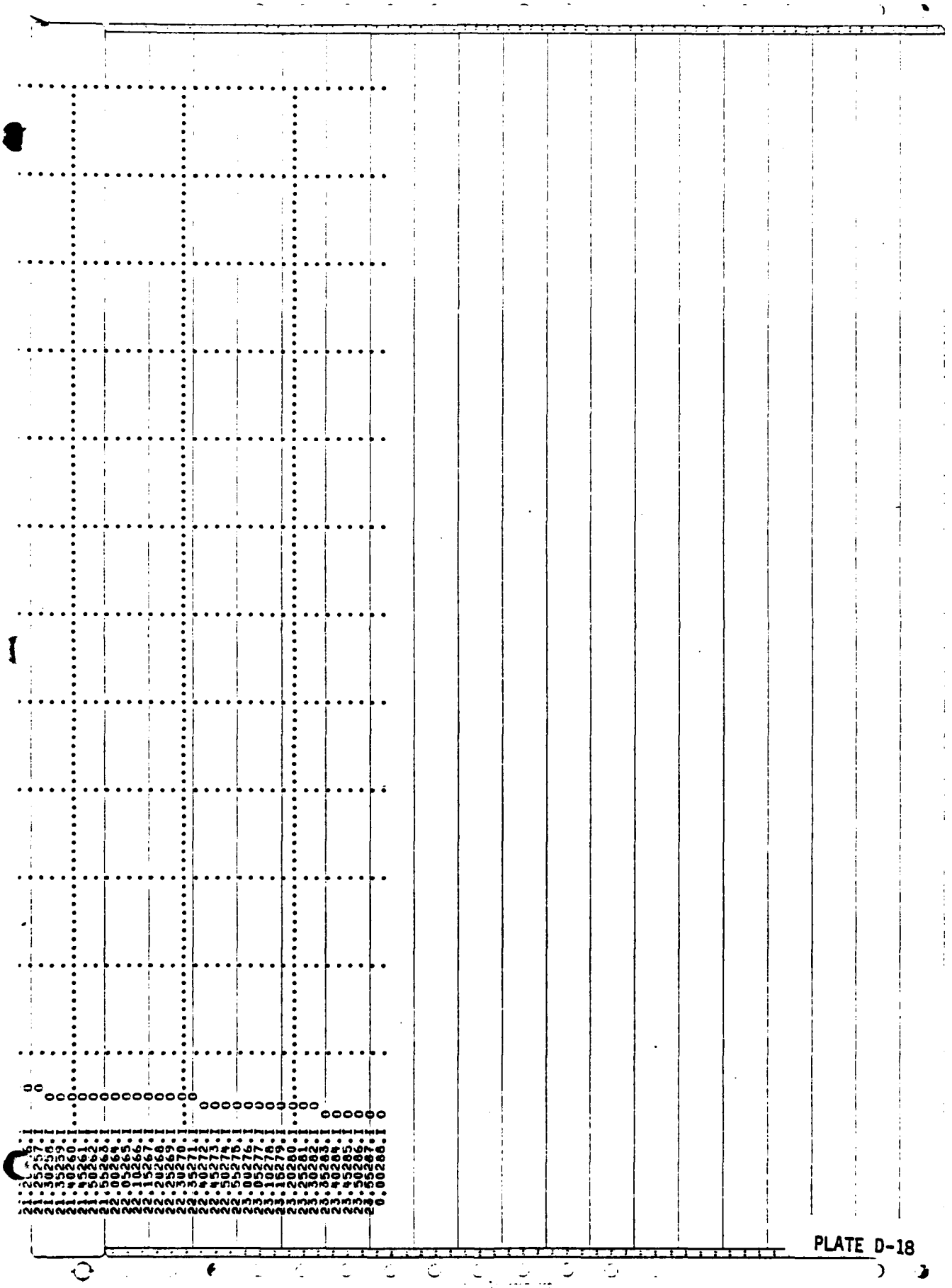


PLATE D-18

OVN

STATION 000002, PLAN 1, RATIO 8 0.5 PMF

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	1.	1.	1.	1.	1.
1.	1.	2.	2.	2.	2.	3.	3.	3.	3.
3.	4.	4.	4.	4.	5.	5.	5.	5.	6.
6.	6.	6.	7.	7.	7.	8.	8.	9.	9.
10.	10.	11.	11.	11.	12.	12.	13.	13.	13.
14.	14.	14.	15.	15.	16.	16.	16.	16.	17.
17.	17.	18.	18.	18.	18.	19.	19.	19.	20.
20.	20.	20.	20.	21.	21.	21.	22.	22.	23.
24.	24.	25.	26.	29.	32.	35.	37.	40.	43.
46.	52.	57.	62.	66.	70.	74.	77.	80.	84.
89.	96.	103.	109.	114.	119.	123.	126.	129.	132.
134.	134.	135.	138.	145.	159.	208.	299.	467.	565.
524.	445.	375.	321.	281.	254.	233.	215.	199.	187.
177.	170.	164.	160.	157.	154.	150.	145.	141.	137.
134.	130.	128.	125.	123.	122.	119.	115.	107.	97.
87.	81.	75.	70.	65.	61.	56.	52.	49.	46.
44.	42.	41.	40.	38.	37.	36.	35.	34.	33.
32.	31.	30.	29.	28.	27.	27.	26.	25.	25.
25.	25.	24.	24.	24.	24.	24.	24.	24.	24.
23.	23.	23.	23.	23.	23.	23.	23.	22.	22.
22.	22.	22.	22.	22.	22.	22.	21.	21.	21.
21.	21.	21.	20.	20.	20.	19.	19.		

STORAGE

40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	41.	41.	41.	41.	41.	41.	41.	41.
41.	41.	41.	42.	42.	42.	42.	42.	42.	42.
42.	42.	43.	43.	43.	43.	43.	43.	43.	43.
43.	44.	44.	44.	44.	44.	44.	44.	44.	44.
44.	44.	44.	45.	45.	45.	45.	45.	45.	45.
45.	45.	45.	45.	45.	45.	45.	45.	46.	46.
46.	46.	46.	46.	46.	46.	46.	47.	47.	47.
48.	48.	49.	49.	50.	50.	51.	51.	51.	52.
52.	53.	53.	54.	54.	54.	55.	55.	55.	55.
56.	56.	56.	57.	57.	57.	57.	57.	58.	58.
58.	58.	58.	58.	58.	59.	60.	63.	65.	66.
65.	65.	64.	63.	62.	62.	61.	61.	60.	60.
59.	59.	59.	59.	59.	59.	59.	58.	58.	58.
58.	58.	58.	57.	57.	57.	57.	57.	57.	56.
56.	55.	55.	54.	54.	54.	53.	53.	53.	52.
52.	52.	52.	51.	51.	51.	51.	51.	50.	50.
50.	50.	50.	50.	50.	49.	49.	49.	49.	49.
49.	49.	49.	49.	48.	48.	48.	48.	48.	48.
48.	48.	48.	48.	47.	47.	47.	47.	47.	47.
47.	47.	47.	47.	47.	46.	46.	46.	46.	46.
46.	46.	46.	46.	46.	46.	46.	45.		

STAGE

508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0
508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0
508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0
508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0
508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0
508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0
508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0
508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.1	508.1	508.1
508.1	508.1	508.1	508.1	508.1	508.2	508.2	508.2	508.2	508.2
508.2	508.3	508.3	508.3	508.3	508.3	508.4	508.4	508.4	508.4
508.4	508.4	508.5	508.5	508.5	508.5	508.5	508.5	508.6	508.6
508.6	508.6	508.6	508.6	508.7	508.7	508.7	508.7	508.7	508.7
508.7	508.8	508.8	508.8	508.8	508.8	508.8	508.8	508.8	508.8
508.9	508.9	508.9	508.9	508.9	508.9	508.9	508.9	508.9	508.9
509.0	509.0	509.0	509.0	509.0	509.0	509.1	509.1	509.2	509.2

PLATE D-19

510.0	510.1	510.1	510.2	510.3	510.3	510.4	510.4	510.4	510.5
510.5	510.6	510.6	510.7	510.7	510.7	510.7	510.8	510.8	510.8
510.8	510.8	510.8	510.8	510.9	511.0	511.2	511.5	511.8	512.0
511.9	511.8	511.7	511.6	511.5	511.4	511.3	511.2	511.2	511.1
511.1	511.0	511.0	511.0	511.0	511.0	510.9	510.9	510.9	510.8
510.8	510.8	510.8	510.8	510.7	510.7	510.7	510.7	510.6	510.6
510.5	510.4	510.4	510.3	510.2	510.2	510.1	510.1	510.0	510.0
510.0	509.9	509.9	509.9	509.8	509.8	509.8	509.7	509.7	509.7
509.7	509.6	509.6	509.6	509.6	509.6	509.5	509.5	509.5	509.5
509.5	509.5	509.4	509.4	509.4	509.4	509.4	509.4	509.3	509.3
509.3	509.3	509.3	509.3	509.2	509.2	509.2	509.2	509.2	509.2
509.2	509.1	509.1	509.1	509.1	509.1	509.1	509.1	509.0	509.0
509.0	509.0	509.0	509.0	509.0	508.9	508.9	508.9		

PEAK OUTFLOW IS 565. AT TIME 15.83 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	565.	149.	46.	46.	15245.
CMS	16.	4.	1.	1.	375.
INCHES		12.13	15.01	15.01	15.01
MM		308.21	381.26	381.26	381.26
AC-FT		74.	91.	91.	91.
THOUS CU M		91.	113.	113.	113.

PLATE D-20

OVF

STATION000002

INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)

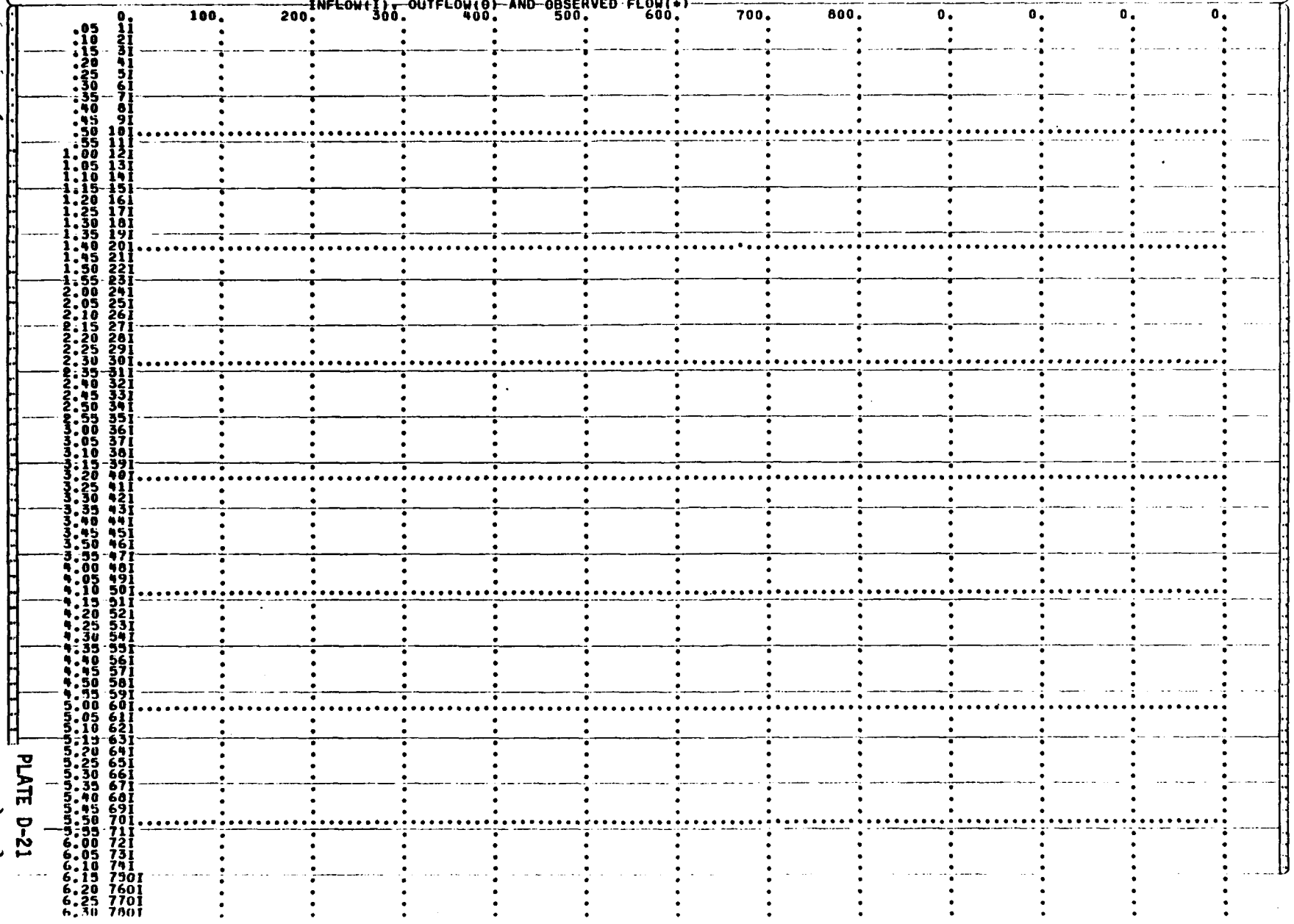


PLATE D-21

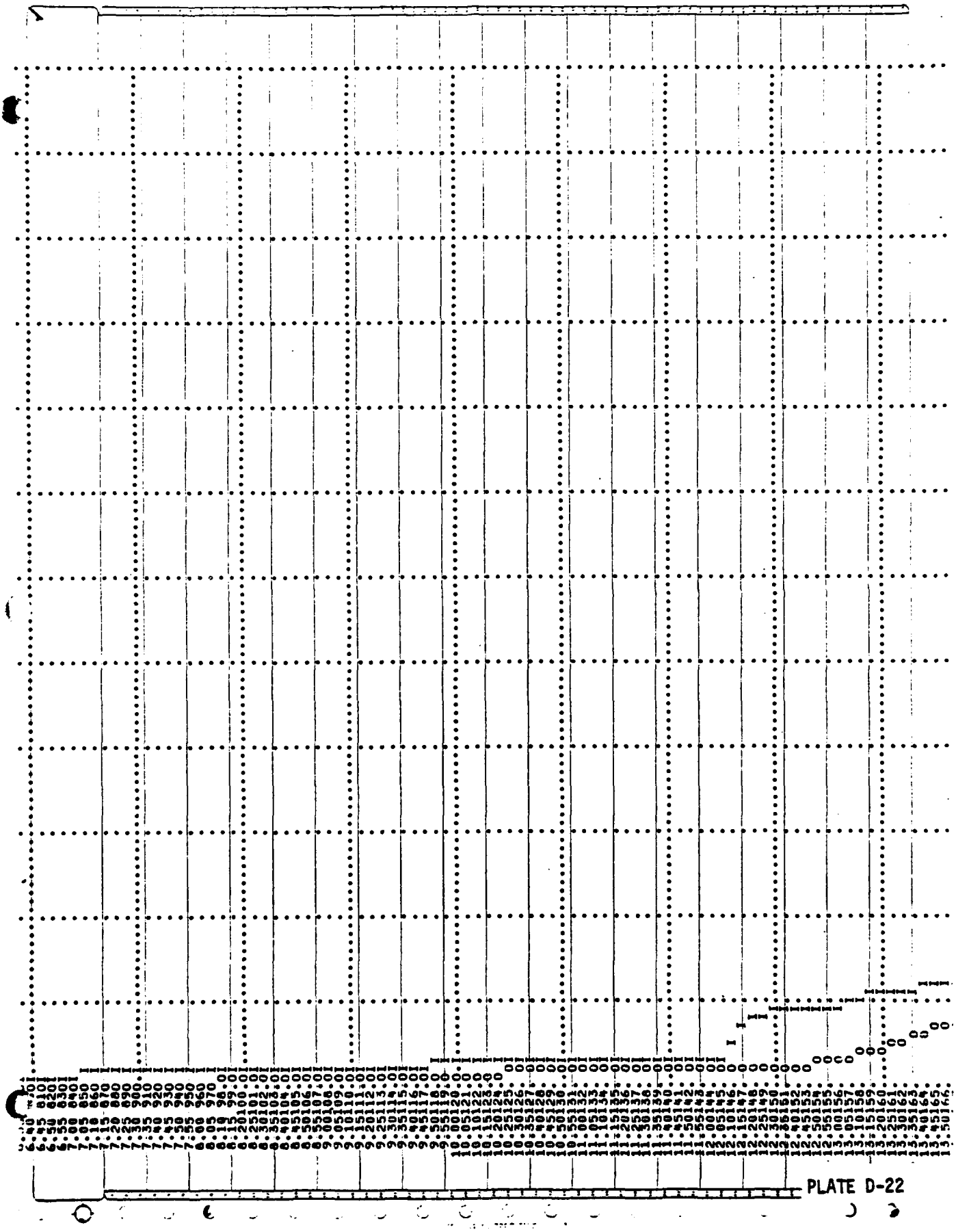


PLATE D-22

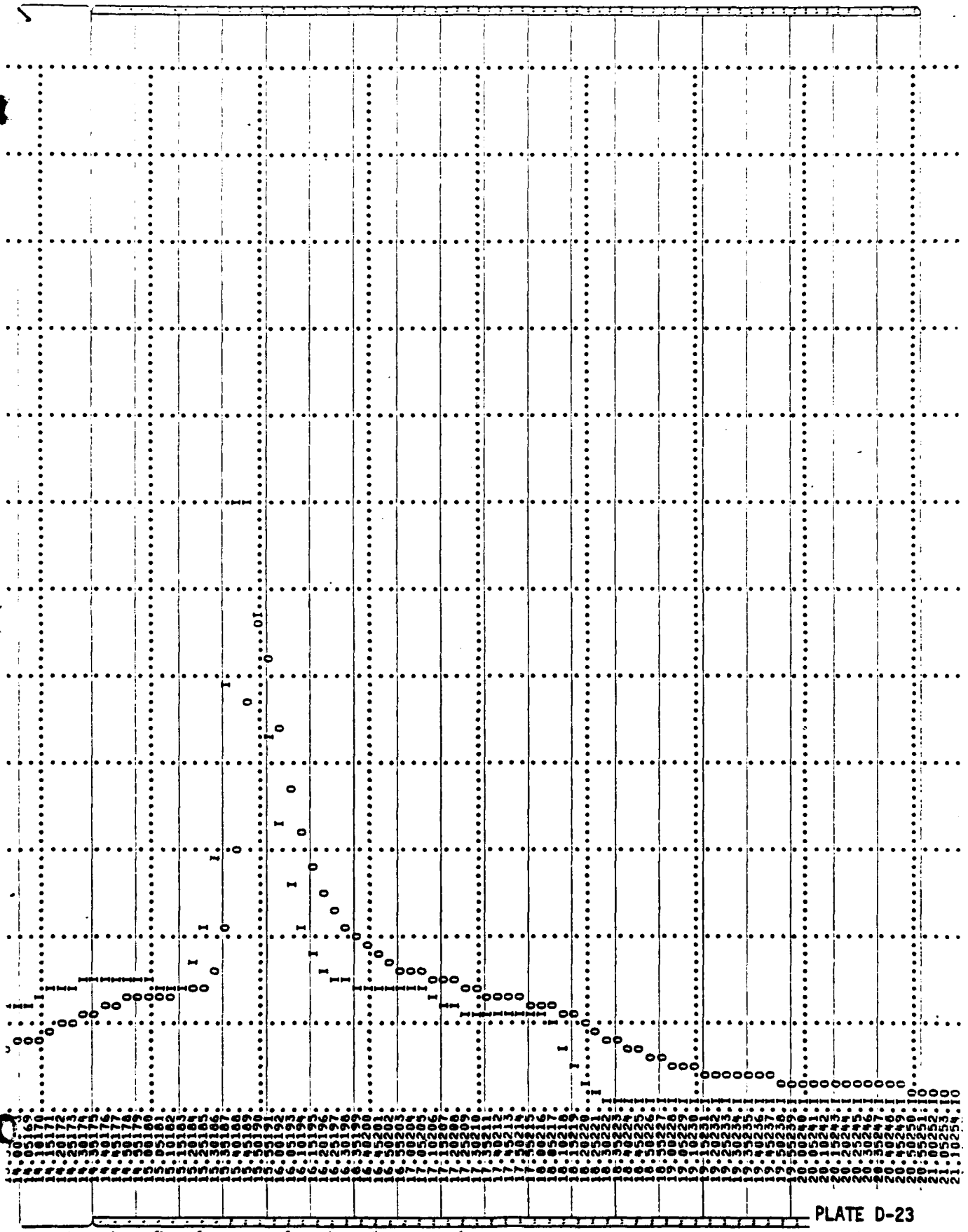


PLATE D-23

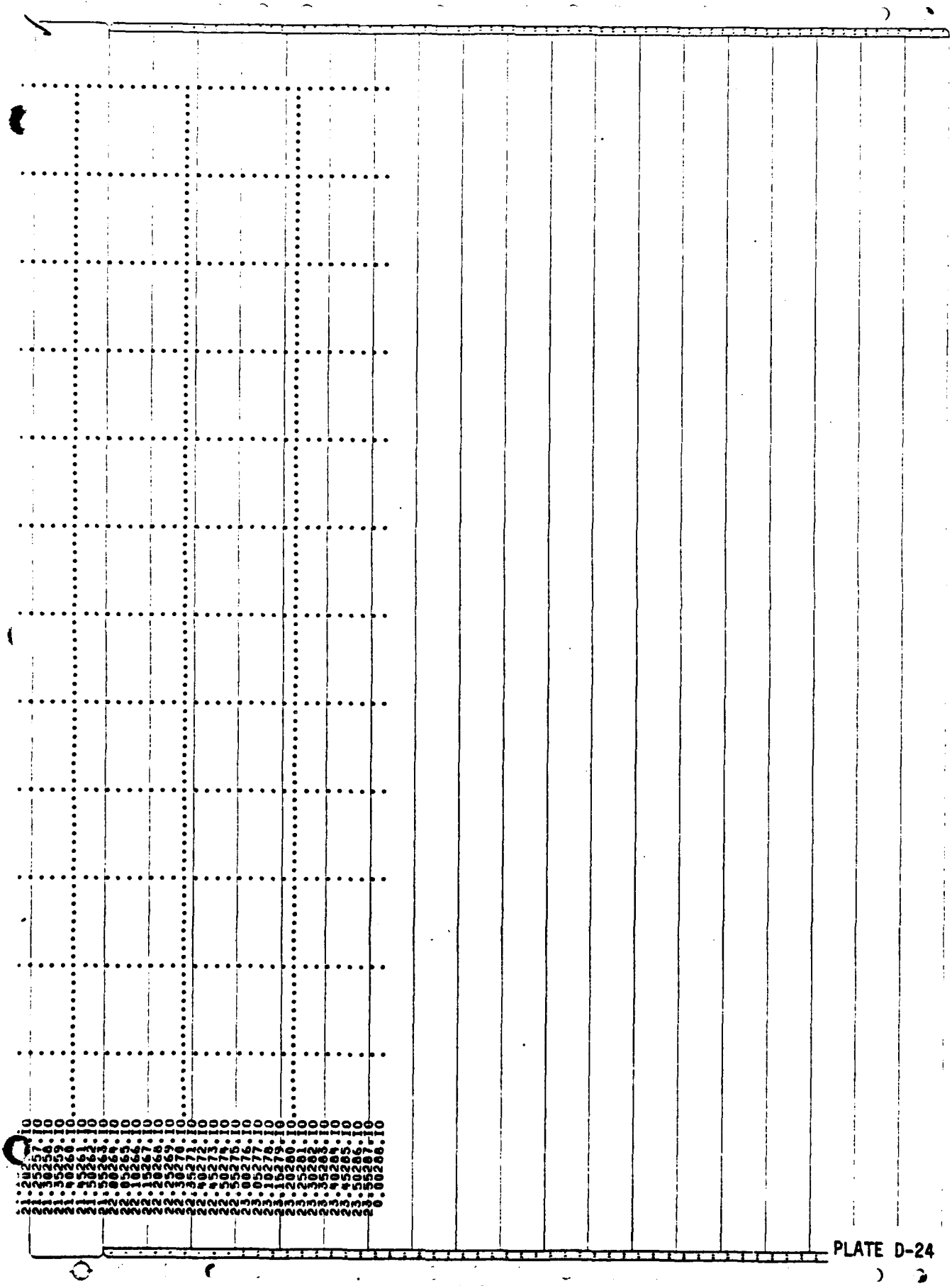


PLATE D-24

OVN

STATION 000002, PLAN 1, RATIO 9 PMF

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	1.	1.	1.	1.	1.	1.	2.	2.	2.
3.	3.	3.	4.	4.	5.	5.	5.	6.	6.
7.	8.	9.	10.	10.	11.	12.	13.	14.	15.
16.	17.	18.	18.	19.	20.	21.	21.	21.	22.
22.	22.	22.	23.	23.	23.	23.	23.	24.	24.
24.	24.	25.	25.	25.	27.	28.	29.	30.	31.
32.	33.	33.	34.	35.	36.	37.	37.	38.	39.
39.	40.	41.	41.	42.	44.	49.	57.	66.	74.
83.	95.	107.	118.	128.	136.	144.	151.	159.	171.
182.	191.	199.	205.	211.	215.	218.	221.	224.	229.
236.	244.	253.	262.	268.	274.	279.	282.	286.	288.
289.	286.	284.	292.	318.	387.	602.	1081.	1392.	1273.
1016.	796.	636.	527.	449.	396.	360.	336.	319.	307.
300.	294.	291.	288.	205.	281.	274.	265.	257.	250.
244.	240.	236.	233.	231.	229.	225.	215.	194.	168.
149.	132.	117.	104.	92.	83.	78.	73.	69.	65.
61.	57.	54.	51.	48.	46.	44.	43.	42.	41.
40.	39.	38.	37.	37.	36.	35.	34.	34.	33.
32.	32.	31.	31.	30.	30.	29.	29.	28.	28.
27.	27.	27.	26.	26.	25.	25.	25.	25.	25.
25.	25.	25.	25.	25.	24.	24.	24.	24.	24.
24.	24.	24.	24.	24.	24.	24.	24.		

STORAGE

40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	40.	40.
40.	40.	40.	40.	40.	40.	40.	40.	41.	41.
41.	41.	41.	41.	42.	42.	42.	42.	42.	43.
43.	43.	43.	43.	44.	44.	44.	44.	44.	45.
45.	45.	45.	45.	46.	46.	46.	46.	46.	46.
47.	47.	47.	47.	47.	47.	48.	48.	48.	48.
48.	49.	49.	49.	49.	49.	50.	50.	50.	50.
50.	50.	50.	51.	51.	51.	51.	51.	51.	51.
51.	52.	52.	52.	52.	52.	53.	53.	54.	55.
55.	56.	57.	57.	58.	58.	58.	59.	59.	59.
60.	60.	60.	60.	60.	61.	61.	61.	61.	61.
61.	61.	62.	62.	62.	62.	62.	62.	62.	63.
63.	62.	62.	63.	63.	64.	66.	68.	70.	69.
68.	67.	66.	65.	65.	64.	64.	63.	63.	63.
63.	63.	63.	63.	62.	62.	62.	62.	62.	62.
61.	61.	61.	61.	61.	61.	61.	61.	60.	59.
58.	58.	57.	56.	56.	55.	55.	55.	54.	54.
54.	53.	53.	53.	53.	52.	52.	52.	52.	52.
52.	51.	51.	51.	51.	51.	51.	51.	50.	50.
50.	50.	50.	50.	50.	50.	50.	50.	50.	50.
49.	49.	49.	49.	49.	49.	49.	49.	49.	49.
49.	49.	49.	49.	49.	49.	49.	49.	49.	48.
48.	48.	48.	48.	48.	48.	48.	48.		

STAGE

508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0
508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0
508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0
508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0
508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0
508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0
508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0	508.0
508.0	508.0	508.0	508.0	508.1	508.1	508.1	508.1	508.1	508.2
508.2	508.2	508.2	508.3	508.3	508.3	508.4	508.4	508.4	508.5
508.5	508.5	508.6	508.6	508.6	508.7	508.7	508.7	508.8	508.8
508.8	508.8	508.9	508.9	508.9	509.0	509.0	509.0	509.0	509.1
509.1	509.1	509.2	509.2	509.2	509.3	509.3	509.3	509.3	509.4
509.4	509.4	509.5	509.5	509.5	509.5	509.6	509.6	509.6	509.6
509.7	509.7	509.7	509.7	509.8	509.8	509.8	509.8	509.8	509.8
509.9	509.9	509.9	509.9	509.9	510.0	510.0	510.1	510.3	510.4

511.1	511.1	511.2	511.2	511.2	511.2	511.2	511.3	511.3	511.3
511.3	511.3	511.4	511.4	511.4	511.5	511.5	511.5	511.5	511.5
511.5	511.5	511.5	511.5	511.6	511.7	512.0	512.3	512.5	512.4
512.3	512.2	512.0	511.9	511.8	511.7	511.7	511.6	511.6	511.6
511.5	511.5	511.3	511.5	511.5	511.5	511.5	511.4	511.4	511.4
511.3	511.3	511.3	511.3	511.3	511.3	511.3	511.2	511.1	511.0
510.9	510.8	510.7	510.6	510.5	510.5	510.4	510.3	510.3	510.2
510.2	510.1	510.1	510.1	510.0	510.0	510.0	510.0	509.9	509.9
509.9	509.9	509.8	509.8	509.8	509.8	509.8	509.7	509.7	509.7
509.7	509.7	509.7	509.6	509.6	509.6	509.6	509.6	509.6	509.6
509.6	509.5	509.5	509.5	509.5	509.5	509.5	509.5	509.5	509.5
509.5	509.5	509.5	509.5	509.4	509.4	509.4	509.4	509.4	509.4
509.4	509.4	509.4	509.4	509.4	509.4	509.4	509.4		

PEAK OUTFLOW IS 1392. AT TIME 15.75 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1392.	316.	93.	93.	26905.
CMS	39.	9.	3.	3.	762.
INCHES		25.76	30.49	30.49	30.49
MM		654.19	774.50	774.50	774.50
AC-FT		157.	185.	185.	185.
THOUS CU M		198.	229.	229.	229.

PLATE D-26

OVF

STATION000002

INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)

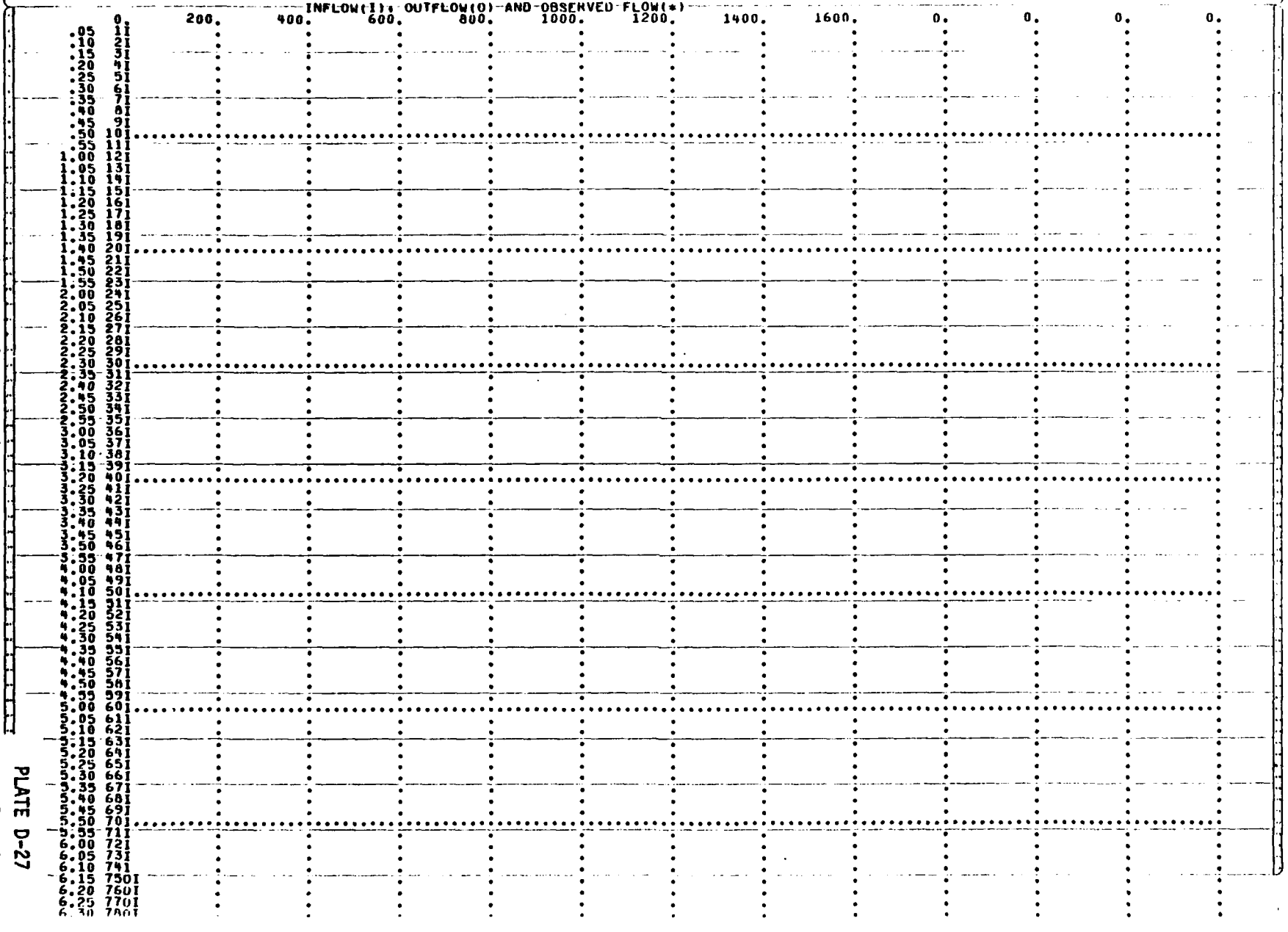


PLATE D-27

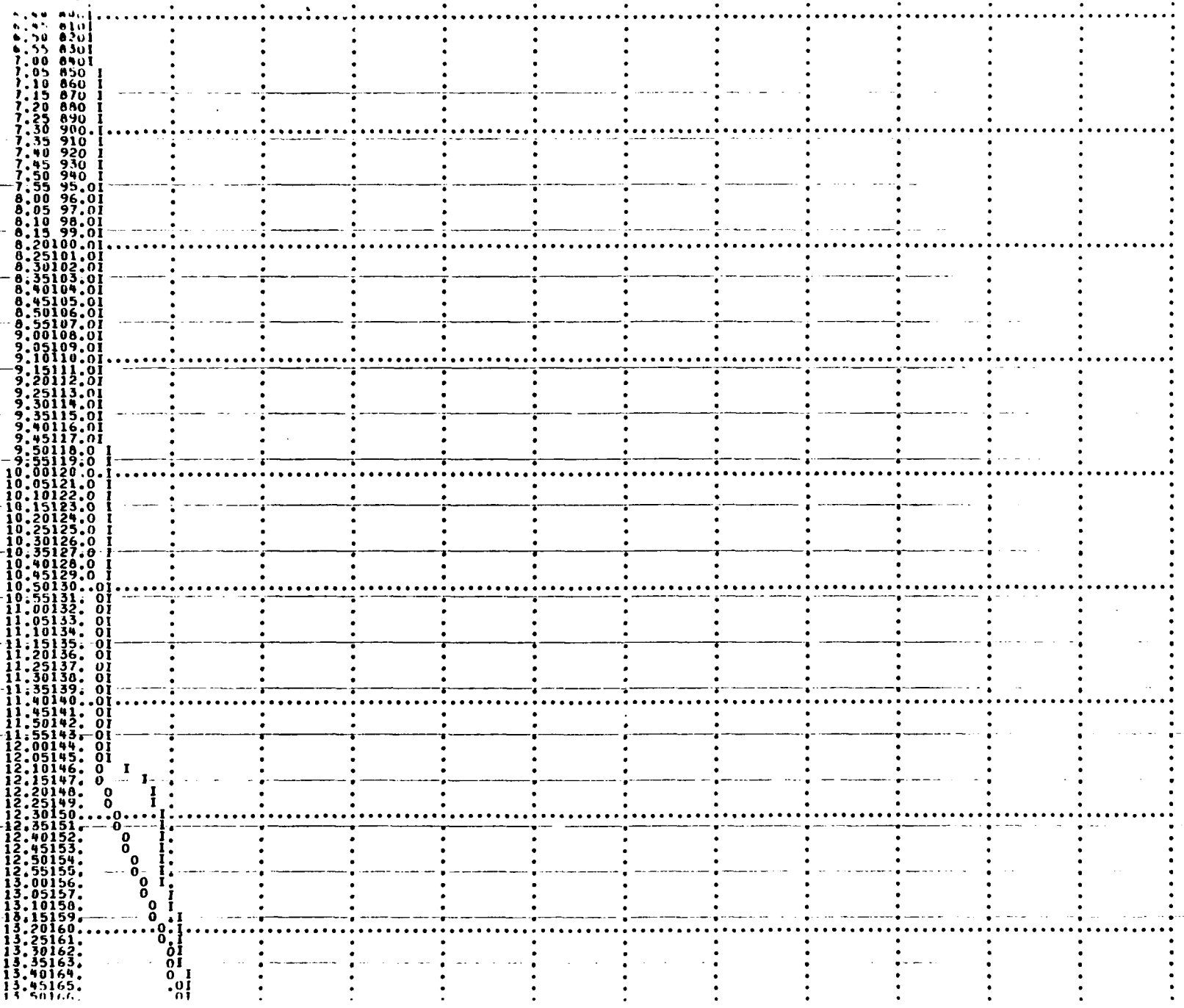


PLATE D-28

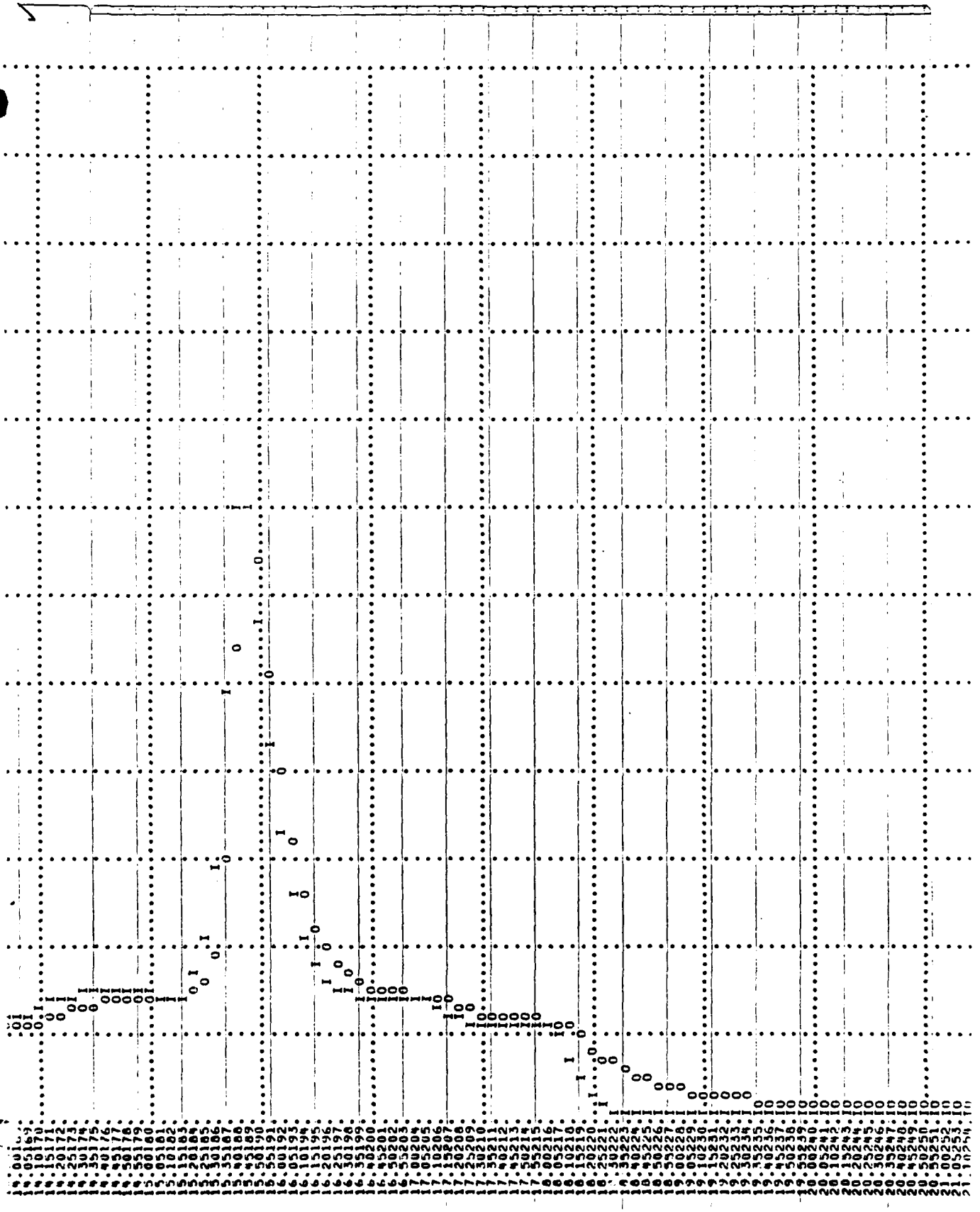


PLATE D-29

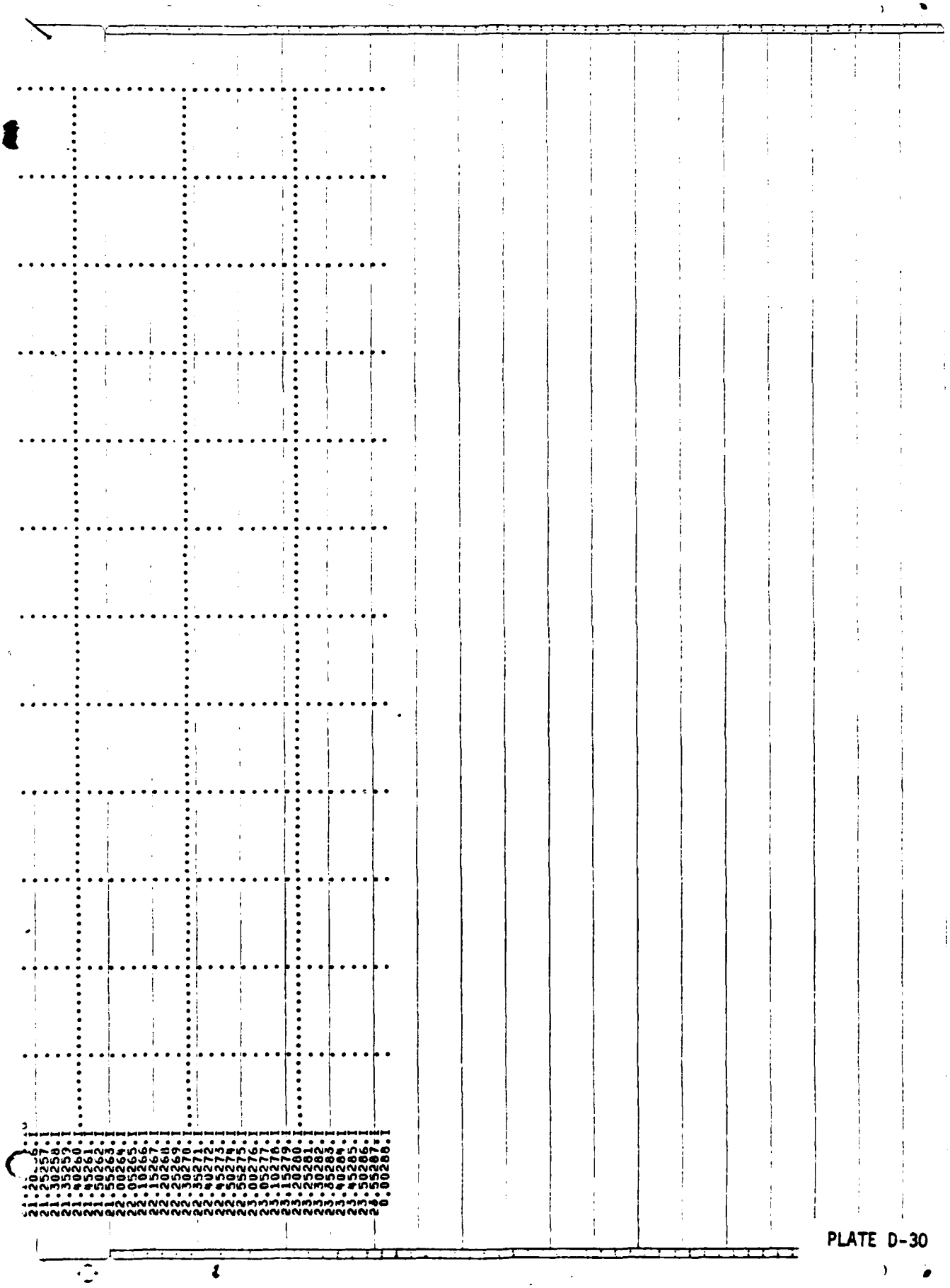


PLATE D-30

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS								
				RATIO 1 .15	RATIO 2 .20	RATIO 3 .25	RATIO 4 .30	RATIO 5 .35	RATIO 6 .40	RATIO 7 .45	RATIO 8 .50	RATIO 9 1.00
HYDROGRAPH AT	000001	.11	1	211.	282.	352.	422.	493.	563.	634.	704.	1408.
		(.30)	(	5.98)(	7.97)(	9.97)(	11.96)(	13.96)(	15.95)(	17.94)(	19.94)(	39.87)
ROUTED TO	000002	.11	1	50.	109.	170.	236.	305.	382.	467.	565.	1392.
		(.30)	(	1.63)(	3.10)(	4.80)(	6.68)(	8.65)(	10.82)(	13.23)(	15.99)(	39.41)

PLATE D-31

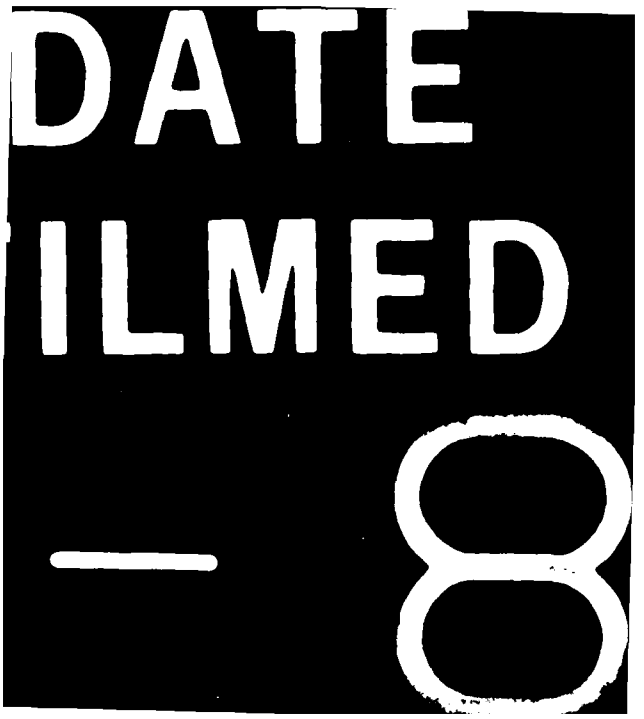
SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	508.00	508.00	511.30
STORAGE	40.	40.	61.
OUTFLOW	0.	0.	233.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.15	510.15	0.00	53.	58.	0.00	16.25	0.00
.20	510.66	0.00	57.	109.	0.00	16.00	0.00
.25	511.04	0.00	59.	170.	0.00	16.00	0.00
.30	511.31	.01	61.	236.	.17	15.92	0.00
.35	511.55	.25	63.	305.	.50	15.92	0.00
.40	511.71	.41	64.	382.	.58	15.92	0.00
.45	511.85	.55	65.	467.	.75	15.83	0.00
.50	511.96	.66	66.	565.	.75	15.83	0.00
1.00	512.49	1.19	70.	1392.	3.67	15.75	0.00

PLATE D-32


DATE
ILMED
8